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Performance Evaluation of a Triangular-Prism Solar Still using Bagasse as a Porous Medium in the Malaysian Climate

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ABSTRACT

The Solar Still System is a technology that applies fundamental concepts of water evaporation and condensation, making it easier to turn unclean or salty water into potable water through solar heat energy. This study focuses on Triangular-Prism Solar Still (TPSS), which has a distinctive physical structure that uses large surface areas on both sides to promote the retention of high temperatures inside the Solar Still area. The difference in internal and external temperatures of the Solar Still will encourage the formation of clean water droplets and, with the inclination of each side wall, help collect clean water. This experiment uses a Galvanized Steel tray to act as Phase Change Material (PCM); 100ml was produced within 4 to 5 hours of the operation. Using sugarcane bagasse as porous material results in a 2% improvement in overall performance. With the help of Thermo Electric components, two units of Peltier improved the significant result by increasing the 5% TPSS humidity. This study also showed better performance when using clean water than dirty water.

1. Introduction

Water, or in scientific codes as H_20, is a polar inorganic compound commonly in solid, liquid, or gas conditions. Usually, pure water is odorless, tasteless, and colorless. The nutrition information provided by USDA states that one cup of purified water has zero (0) calories, 0g protein, 0g carbohydrate, and 0g fat [1]. As a part of the liquid, water can be purified by other processes, including capacitive deionization, carbon filtering, electro-deionization, reverse osmosis, microfiltration, ultrafiltration, or ultraviolet oxidation.

According to the World Health Organization, reported in Mac 2022, most of the world's population, with 74% of the population in the 5.8 billion people, uses safely managed-to-drink water services. On the other hand, almost 2 billion people live under water stress in some regions, especially in the Middle East and Africa [2]. From 2025 to 2030, the world is predicted to experience a water

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crisis that is so serious that it might kill billions of people and disrupt current ecosystems, according to data and studies from numerous authorities around the country [3,4]. By 2040, it is predicted that just 40% of the world's total water supply will be usable. The predicament is so dire that 600 children are headed for water shortages [5]. According to the Department of Chemistry Malaysia, good drinking water from Organic or Inorganic sources complies with the National Standard for Drinking Water Quality under The National Drinking Water Quality Surveillance Program (NDWQS).

Over a decade, most researchers and scientists in the Middle East, India, China, and Africa have continued their studies to produce drinking water using Solar Desalination Systems, or Solar Still (SS). Present studies regarding solar still development have been rapidly investigated to overcome the central issue of its low productivity and safe bottled water per day. Solar Still is a part of the water cleaning process solution using the distillation idea. Several types with different characteristics have recently been discovered to improve the performance of solar power. This paper is focused on Triangular-Prism Solar Still (TPSS) on working methods, thermal analysis, arrangement, and method enhancement.

This model implements an additional heater using Peltier and investigates the porous sugarcane bagasse as a Phase Change Material (PCM) component to improve the system's performance. This portable system may be helpful to residents who live in crucial clean water resources, especially in deep-lying areas and areas affected by floods.

2. Methodology

This prototype consists of two primary hardware circuits. The Peltier Module has been applied to promote the heating temperature, and Galvanized Steel trays were used as water containers. Both primary parts were attached to this Triangular-Prism Solar Still (TPSS). Traditionally, solar still depends on direct sunlight heat for the whole TPSS component. Still, with Peltier's assistance, the desired temperature can be maintained and processed with the aid of renewable energy by solar.

Solar Still Systems generally transform dirty or salted water using the Sun’s heat energy, directly hitting the glass topper surface to drive the evaporation process and produce raw water. The main idea is based on the principles of evaporation and condensation of water, either from brackish or seawater. Multiple varieties of Solar Stills have been identified by researchers, including Single Slope Solar Stills, Tubular Solar Stills, Solar Stills with Passive Condensers, V-Type Solar Stills, Hemispherical Solar Stills, and Double Slope Basin Solar Stills [6]. There are different kinds of SSs, like pyramid SS, tube SS, inclined SS, flat SS, multi-basin double-slope SS (DS), and stepped SS. Nanofluids, nano-coating, thin-film evaporation, phase change materials (PCMs), wick material, hydrogel materials, v-corrugated aluminum basin, cotton hung pad with nano, carbonized wood with nano, reflectors, energy storage, nano-based mushrooms, heat localization materials, cover cooling, graphene nano-ratchet, evacuated tubes, porous absorber, solar collector, and hybrid systems represent some of the most popular other options [7-10].

Four (4) main components are required in Solar Still (SS) System design. A basin or water tank for the evaporated water collection channel. This top glass cover will act as a medium to absorb the heat from the sun and insulation, as an example of a traditional Single-Basin Solar still in Figure 1 [11]. Several studies have addressed the factors that impact the performance of the different solar stills, the materials used in stills, and the design techniques for and possible applications of stills [12].

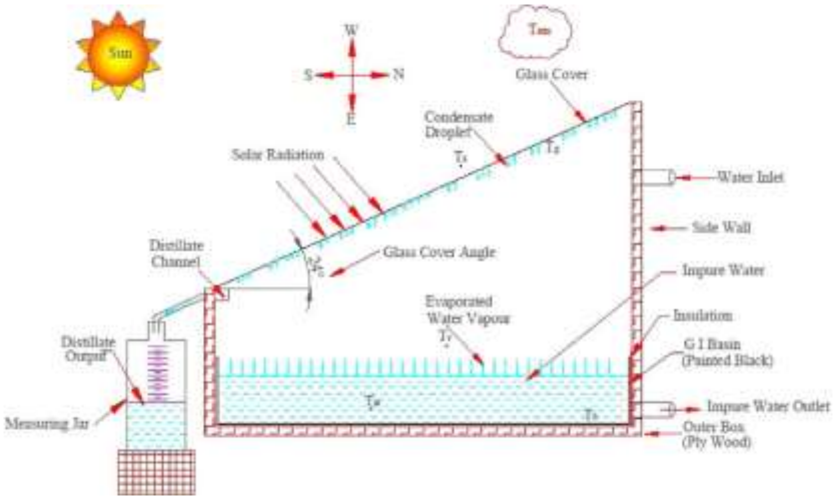

Fig. 1. A traditional SBSS [11]

Solar Still is structured with transparent glasses according to the designs. This plant needs to be placed in an outdoor and open area, which requires the heat from the sun to strike it. Technically, during the day, when the Sun's radiation increases past the afternoon, the brackish or seawater evaporates due to the sun's heat trapped on the top glass cover. Therefore, the internal temperature will increase, and brackish or seawater will be evaporated inside the solar still room. Tiny particles of droplets on the inside surface of the top glass flared up from brackish or seawater basins. The entire glass cover should have a certain angle to draw the evaporated water shallowly immediately into the collector channel and then go into a water tank or beaker. These SS should be placed in an open area with enough heat to operate. The performance of water evaporation will decrease during the sunset.

To improve the performance of traditional Solar Still System design, an active Solar Still system requires some mechanical source within the collector or thermal storage minerals assisted by a solar power system. A study by Abbaspour *et al.,* [13] applied wick material to his Vertical Solar Still, which significantly impacted the performance with an optimum configuration size [13]. As a result, active solar still might utilize measurable distilled output water productivity, while higher solar is still powered by the sun passively. Several studies focused on the design, method, material, surface glass pattern, solar radiation effect, temperature, and eco-friendly water absorber using porous materials, which slightly help to boost up the raw water collection. Certain factors, like the quantity of water within the basin, higher sun heat radiation averages, and ambient weather, might affect the rate at which the SSs work. Li Hao's studies on Tubular Solar stills proved that the metrological parameters could be the main factor in increasing the Solar Still's performance in terms of Solar Intensity, Air Temperature, Air Velocity, Relative Humidity, and Cloud and Dust Cover [14].

Figure 2 shows the general process of this prototype operation. When Peltier generates heat, the water temperature rises whenever the sun's radiation cannot achieve it. Fundamentally, Peltier was built on a P-N terminal, where one plate generates heat while the other has a cold area. Prior research indicated that the Triangular-Prism Solar Still (PSS) could produce more distilled freshwater than the Pyramid Solar Still. Numerous investigations were conducted using Triangular-Prism Solar Stills to determine their efficacy, and their designs were built according to previous studies' recommendations, as seen in Figure 5. As mentioned in the last section, the basic Triangular Prism Solar Still design (PSS) could produce better output than the Pyramid Solar Still.

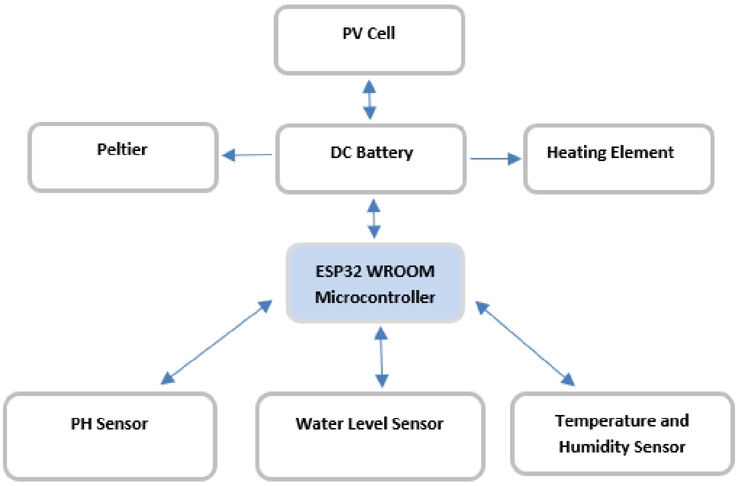

Fig. 2. Circuit block diagram

Using the dimension of 11.53 cm x 60cm x 40cm, each side of the slopes was configured at a 30° angle as recommended in previous studies, allowing the adequate performance of water collection. This Triangular-Prism glass was placed on the top of square wood, with dimensions of 40cm x 60cm, quite enough to put a 45 cm x 30 cm x 10cm galvanized steel base as a tray. The inclination height of the system effectively facilitates the trap of water vapor. Figure 4 shows the prototype of the system for this experiment. The structure of Solar Still Design could impact the performance in terms of various parameters, which helps to raise the internal evaporation process consistently.

According to study by Mohsenzadeh *et al.,* [15] on Passive Solar Stills (PSS), collector and receiver design has proven to significantly improve PSS performance in terms of the different numbers of reflectors, the angle of the transparent cover on the top of yield, and appropriate material. Convective heat transfer between the evaporating and condensing surface of Stepped Basin Solar Still (SBSS) leads to an optimum result compared to the Two-Dimensional Stepped Basin Single Slope (TD-SBSS) [16]. At the same time, the Stepped Solar Still studies by Kabeel *et al.,* [4] found the experiment in the Stepped Design could be more effective than conventional solar still in terms of the number of steps with Multi-Tray Evaporator (MTE) at rear wall proven enhancement in distillate water output and efficiency [17]. In another finding by AK. Mishra focuses on the internal heat and mass transfer of Active Solar Still inclination of condensing cover increased. In contrast, the evaporation heat transfer coefficient decreases because of the significant increase in the temperature difference between the water mass surface and condensing cover on an increase in the inclination of the condensing cover. The condensing cover was recommended to obtain not more than 60◦ of inclination slope; the higher glass mass will cause breakage and various design problems [18].

Tuly's *et al.,* [19] experiment on Active Double Slope Solar Still modified the model as in Figure 3 by placing an internal sidewall reflector, hollow circular fins, and nanoparticle-mixed phase material. The combined influence of circular fin, glass, and nano-PCM could deliver 21.56% of maximum energy efficiency [19]. Their research analyzed five cases regarding productivity, thermal performance, and cost-effectiveness. With the aid of Aluminium Oxide (Al_2O_3), Nanoparticles resulted in a 92% increase in accumulation, producing 185,000 milliliters daily. The experimental investigation of a Double Slope Active Solar Still by Mohamadi *et al.,* [20] focused on the effect of a new heat exchanger where the highest overall efficiency result from a Novel Design Heat Exchanger (NDHE) is 39.4% compared to Parallel Channels and Serpentine heat exchanger. He chooses 13° for the condensing cover angle to increase the collection for all vaporized droplets. During his experiment, maximum and average brine temperatures 3° Celsius higher using NDHE could drive the force of the distillation process [20].

Different arrangements and additives in basic design can increase the performance of Solar Still, as proven by their experiments.

Pyramid Solar Still is part of Passive Solar Still Design and has its specialization. As in the report by Hammoodi *et al.,* [21], Pyramid Solar Still (PSS) has three benefits over other types. PSS can be installed practically everywhere; its slanted surfaces absorb light from all directions, so it doesn't matter how the sun shines. Second, the shadowing cast by the side wall of the pyramid solar still on the water's surface is substantially less than that of other conventional distillers because the condensing area in a pyramid-shaped sun is still higher than in different types. Although the pyramid-shaped solar basin area is still the same, compared to solar with equal basin dimensions, its pyramidal shape's greater condensing size contributes to higher condensing levels [21]. Figure 3 shows the Pyramid Solar Still evaporation and condensation process.

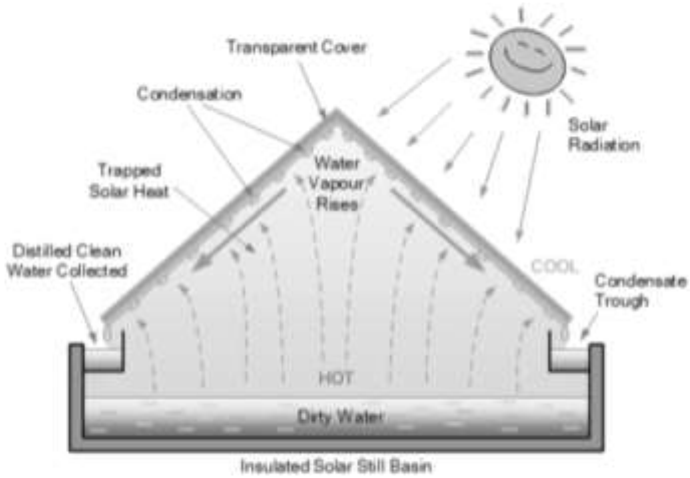

Fig. 3. TPSS evaporation and condensation process [21]

Triangular-Prism Shaped Solar Still (TPSS) had a similar concept to a Pyramid-Shaped Solar Still but had a wide area on both sides. El-Sebaii and Khallaf's [22] research team has observed the prediction of the performance of this design in terms of temperature, heat rates, productivity, and efficiency. The wider size could improve heat trapped inside the module, and a wide basin can be placed inside it. Several studies have observed that Prism Solar Still could perform better than Pyramidal Solar Still because it has slopes on both sides to receive more solar flux [22]. The three-dimensional numerical study of doubly diffusive convection of the air-vapor mixture inside a triangular solar shows that this new design improves the heat and mass transfer rates for specific dimensions [23].

According to the studies from Rahman *et al.,* [24], the fluid flow heat transfer and mass transfer inside the triangular-shaped solar collector will increase with the buoyancy ratio and Rayleigh number increase. The middle axis of the triangular cavity has been found in the symmetric flow field, temperature distribution, and mass distribution. However, local heat transfer and mass transfer have a minimum value at the bottom of the wall due to the stagnation point and motionless fluid at the end, as shown in Figure 4 [24]. According to Hammoodi's *et al.*, [25] studies, using a magnet in an acrylic-based pyramidal distiller could improve yield from 136mT to 200mT while increasing thermal efficiency from 34% to 41.1% compared to the non-magnetized version [25,26].

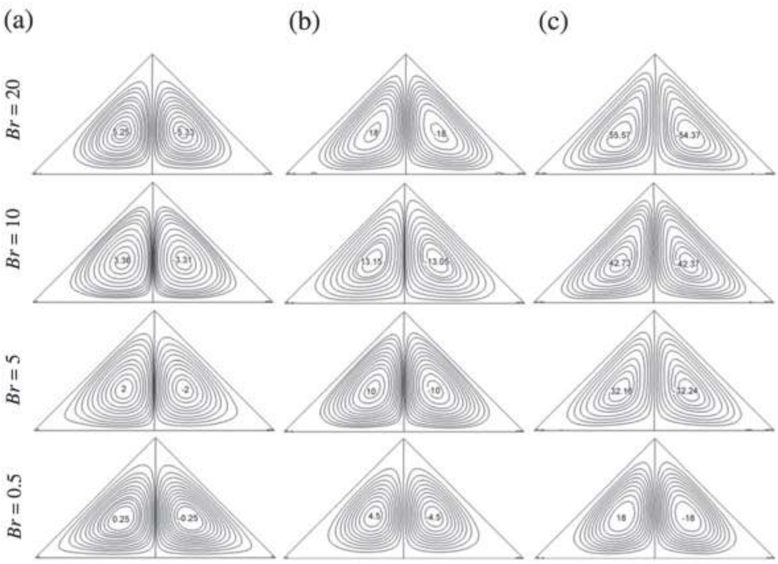

Fig. 4. Effect of buoyancy ratio on streamlines for Ra = 10^4 (b) Ra = 10^5 (c) Ra = 10^6 [24]

Researchers have experimented with various modifications, such as adding components to increase the water's temperature, using cooling air to reduce the glass cover's temperature, and utilizing wind velocity to enhance heat transmission. Enhanced solar stills have also been developed using solar collectors, condensers, low-pressure systems, heat recovery, heat storage, and hybrid PV systems. Porous material could increase the evaporation rates in all types of Solar Distillation, especially in black-colored materials [27]. The studies from Guilong Peng improved the solar still performance by using micro or nanoparticles along with porous material [28]. Using his single-basin solar still with porous fins, Hitesh Panchal's results are 42.3% better than conventional [29]. A hybrid solar distillation developed by Abd Eblar results in an efficiency of 38.07% with back glass but is carried out with preheating at 40%-60% [30].

In another investigation conducted by Abdullah *et al.,* [31] in Saudi Arabia, four (4) wick materials were utilized: jute, cotton, silk, and plush. Pyramid Solar installed three (3) electric heaters supplied by Solar Photovoltaics (PV) at the bottom of the metal basin to raise the water temperature and increase productivity with modified cords. These Cord Pyramid Solar Still (CPSS) with Jute Cloth as a wick and three (3) electrical heaters produce 10,750 mL/m^2 daily, which is 195% better than normal Pyramid Solar Still (PSS) [31]. Modified Pyramid Solar Still (MPSS) by Mohammad Javad introduces three models with two quantities of Circular Copper Fin in the absorber plate in the first and second models. The first model, MPSS1, fits 81 hollow circular copper fins, while the second model, MPSS2, fits 114 concave circular copper fins. As a result, 13.6% is better than MPSS1, with daily productivity reaching 4.47 L/m^2, which increases about 0.36L of salination water. The productivity of his third model of MPSS3 performed better than those two models, with a production output of 62.5%, and he collected 5.33 L/m^2 daily. MPSS3 fits 114 hollow circular copper and glass wool as additional material [32].

Chauhan and Shukla [33] has been observed with Triangular Prism Solar Still (TPSS) build without Phase Change Material (PCM), and Quantum Dot's (QD) material shows the productivity could increase up to 1660 ml/m^2 per day while with PCM only can reach to 2360 ml/m^2 per day. However, the performance boosts up to 3040 ml/m^2 per day when this module is placed with PCM and QD material. Regarding energy efficiencies, this experiment also shows PSS with both materials performs at 2.20%, utilization efficiency results at 2.20 %, and heating efficiency 1.7% better than without both materials [33]. Investigating copper rods as Phase Change Material (PCM) could increase the melting process and improve the discharge or storage of thermal energy [34]. V-corrugated absorber plates on pyramid solar still had increased thermal storage capabilities, whereas some nanoparticles could also increase productivity [35]. Al-Zurfi *et al.,* [36] have examined the impact of incorporating various PCMs into a flat plate solar collector design using numerical simulations. Even in the dark, solar water heating is possible because to the ideal PCM arrangement, which keeps water temperatures higher for extended periods of time [36]. The findings might offer insightful information about how to use PCMs to increase solar thermal systems' efficiency.

This experiment used the same microcontroller monitoring system to retrieve the required data. An upgrade from the previous study, this prototype uses Solar Energy to provide a monitoring system that operates every day, as shown in Figure 5.

Fig. 5. Prototype of Triangular-Prism Solar Still (TPSS)

3. Result

In the first experiment, this Triangular-Prism Solar Still was placed in an open space to get full sunlight directly on its glass surface and produce normal heat. At first, this TPSS model was placed in several areas and positions to find a better location to perform a better evaporation process. A specific location has been identified far away from any blocking area, which might decrease the heating process during daylight and prevent glass breakage by humans.

A simple IoT data logger system has been developed, as in Figure 6, to obtain data readings for the inner area of TPSS humidity, glass surface temperature, collected water volume, and pH level. Those parameters have been stored in Matlab's ThingSpeaks database.

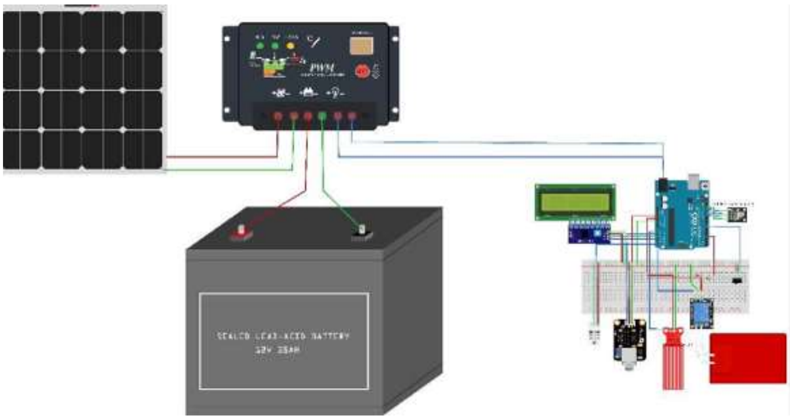

Fig. 6. Solar still monitoring system solar energy assisted

Table 1
Triangular-Prism direct sunlight

Parameter/Time	2:10pm	3:10pm	4:10pm	5:10pm	6:10pm
Water Drop Forming	Low	Low	Normal	High	High
Environment Temperature	31°C	31°C	32°C	34°C	34°C
Humidity	69%	69%	70%	71%	72%
Heater Support	No				
Water Collected	Less than 100ml				
Water Quality	8.22	None	None	None	7.25

This TPSS experiment begins without any additional porous material or TE component. The results were collected from 2.10 pm to 6.10 pm, as shown in Table 1. According to these captured data, the internal temperature of TPSS increased after 4.00 pm because the surface glass took time to heat, and the non-conductive base structure of TPSS, using wood, could prevent heat release from TPSS.

To hold the Triangular-Prism glass cover, the outside base of this system was covered with polystyrene foam placed around to help reduce heat release during evaporation. The humidity level increased by 1% within an hour, and water droplets decreased significantly because of the massive difference between the inside and outside of the glass. The gravity and the tilt angle of solar still glass allow droplets to be collected into the water tank, and 100 ml water volume has been measured. From Figure 7, the TPSS graph indicates the relationship between the environment and humidity. Increasing temperature indirectly helps to increase the percentage of moisture, which promotes the formation of clean water droplets. The clean water sample has also been measured with a pH sensor, which is safe to drink. The pH test is essential to determine the natural clean water level because the material used in the solar still structure consists of iron, plastic, and organic materials. Deciding whether heating will affect the quality of the resulting water is vital. This distillation method of TPSS could form clean water but contains no minerals.

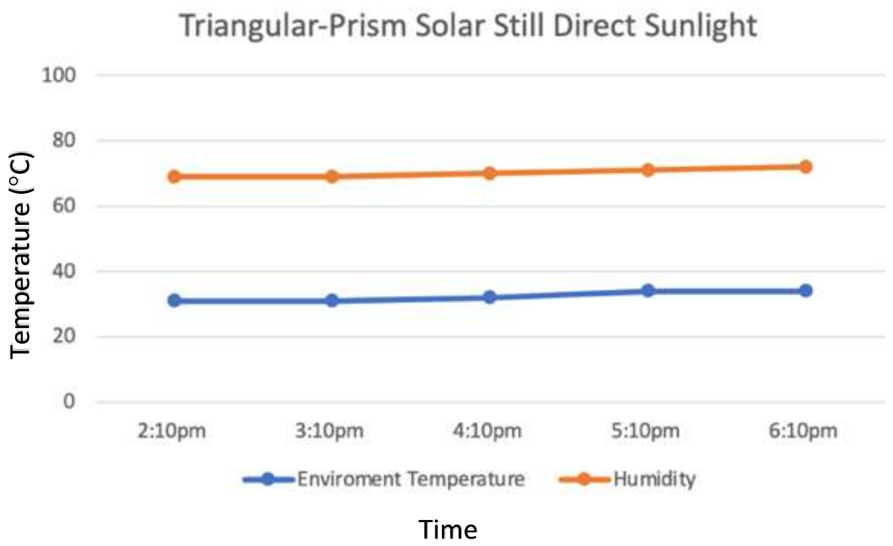

Fig. 7. Triangular-Prism Solar Still temperature and humidity analysis

Based on the success of this experiment with the default setup, sugarcane bagasse was chosen as a mineral porous material for the following experiment, as shown in Figure 8. Mass bagasse, or sugar-cane dregs, was used as our first experiment in Malaysia. Baggase can be effective for evaporation due to its unique characteristics. Typically, it has a high moisture content, which means it can release moisture when it is subjected to heat, and it could help to increase the evaporation process inside the Solar Still Room, and it is safe to use. Three hundred grams of clean bagasse were added to a galvanized steel container filled with four liters of dirty water. The water quality was first evaluated by systematically comparing the measured pH levels.

Fig. 8. The experiment of Bagasse inside Triangular-Prism Solar Still

Table 2 illustrates the results of this second experiment, and Figure 9 shows the moisture and temperature curves, respectively. Compared to the default setup of TPSS, using these porous materials increases the production of clean water, especially the effect on humidity. This situation occurs when hot temperatures are trapped in the sugarcane bagasse heap, and its organic structure slows heat release. Indirectly, it helps increase the formation of water droplets. Upon testing, the pH values of clean water obtained through evaporation were slightly higher than those obtained in the first testing. The presence of bagasse influences the pH of the water and proves faster production would be performed.

Table 2
An experiment of TPSS using bagasse

Parameter/Time	2:10pm	3:10pm	4:10pm	5:10pm	6:10pm
Water Drop Forming	Low	Low	Normal	High	High
Environment Temperature	32°C	32°C	33°C	34°C	34°C
Humidity	70%	72%	75%	77%	79%
Heater Support	No				
Water Collected	None	None	Start drop	Start drop	Less than 100ml
Water Quality	8.22	None	None	None	7.28

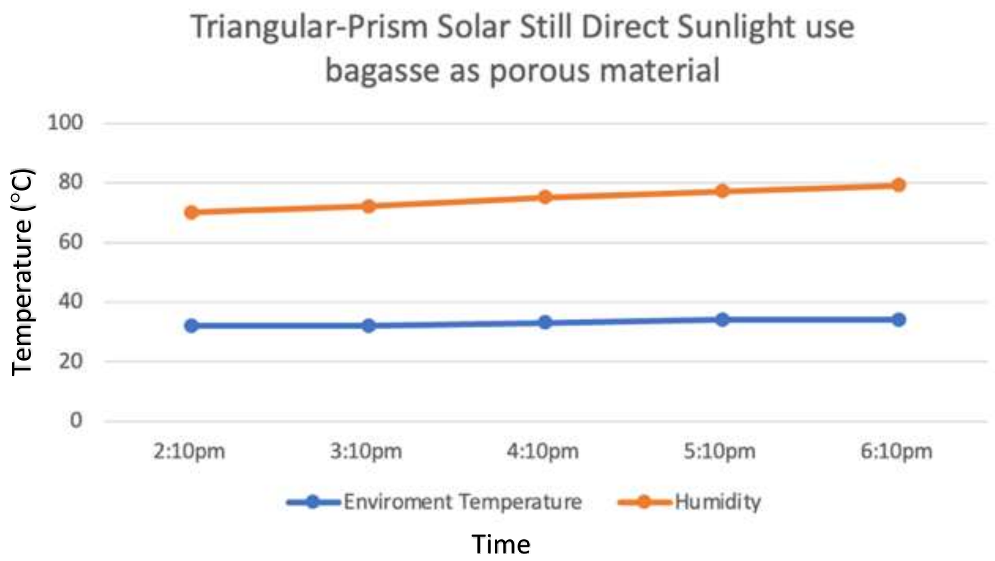

Fig. 9. Triangular-Prism Solar Still temperature and humidity analysis using bagasse

In the third experiment, an additional heater was used by placing four units of Peltier at the bottom of the galvanized steel tray. Combining the sun’s radiant energy, PSS, Peltier, and bagasse as a porous material could boost the overall performance. In theory, these three elements help increase the internal temperature of the solar still. The significant internal and external temperature on the glass construction promotes the formation of water vapor.

Table 3 shows the experiment using clean water and applying heat (Peltier) to the water. Thermal energy increases the kinetic energy of water molecules, causing them to move more vigorously and break free from the liquid phase, transitioning into a gaseous state. The increase in water temperature accelerates the molecular activity within the liquid, resulting in more frequent collisions and more significant energy transfer from the water's surface. This heightened molecular activity boosts the evaporation rate as more water molecules gain sufficient energy to overcome the intermolecular forces holding them within the liquid phase. Consequently, more water molecules can escape into the surrounding atmosphere as water vapor. The combination of heating the water and harnessing the sun's radiant energy in a triangular solar still creates an ideal environment for expediting evaporation. The Peltier will heat the water with solar panels and battery 12V support. The battery connected to the solar controller, also known as a solar charge controller or regulator, regulates and optimizes the charging process of batteries or other energy storage systems connected to solar panels. The solar controller optimizes the charging process by controlling the voltage and current delivered to the batteries. It ensures that the batteries receive the appropriate charging profile. After that, the solar controller is connected to the solar panel, and the out is connected to the temperature controller. The function of a temperature controller is to regulate and control the temperature of a system or environment. The temperature controller allows users to set the desired temperature value, known as the setpoint. Temperature controllers often include safety features to protect the system or environment for the output at the temperature controller connected to the Peltier for heating, resulting in significant clean water production. It proved that this additional setup could increase the 10% of heating temperature and sustain the existing temperature for a more extended period.

Table 3
An experiment of PSS using Bagasse and additional heater (clean water)

Parameter/Time	2:10pm	3:10pm	4:10pm	5:10pm	6:10pm
Water Drop Forming	Low	Normal	Normal	High	High
Environment Temperature	32°C	40°C	46°C	55°C	58°C
Humidity	72%	79%	85%	87%	88%
Heater Support	Yes				
Water Collected	None	Start drop	Start drop	Start drop	Almost 100ml
Water Quality	8.22pH	None	None	None	6.74pH

The graph of Figure 10 shows a drastic increase in temperature and humidity in this TPSS compared to the previous experiment. This proves that using porous materials and Peltiers greatly helps evaporation and condensation. The rate of continuous warming and the decrease in ambient temperature further increase the formation of water droplets towards dusk. It is noted that including a Peltier element in the water reservoir has a notable impact on both temperature and humidity levels. The graphical representation of the collected data provides a clear visualization of the effectiveness of the heating process in significantly expediting the evaporation rate. This acceleration can be attributed to the substantial increase in ambient temperature and humidity facilitated by the heating mechanism. Notably, this accelerated evaporation process yields an impressive production of approximately 100 milliliters of clean water. Upon closer examination, the pH value of the resulting clean water is measured at 6.75. It is essential to note that this pH value falls within the acceptable range of 6.5 to 7.5 to ensure water cleanliness and safety. Therefore, our findings indicate that the heating process implemented has no adverse effects on the pH value of the clean water produced.

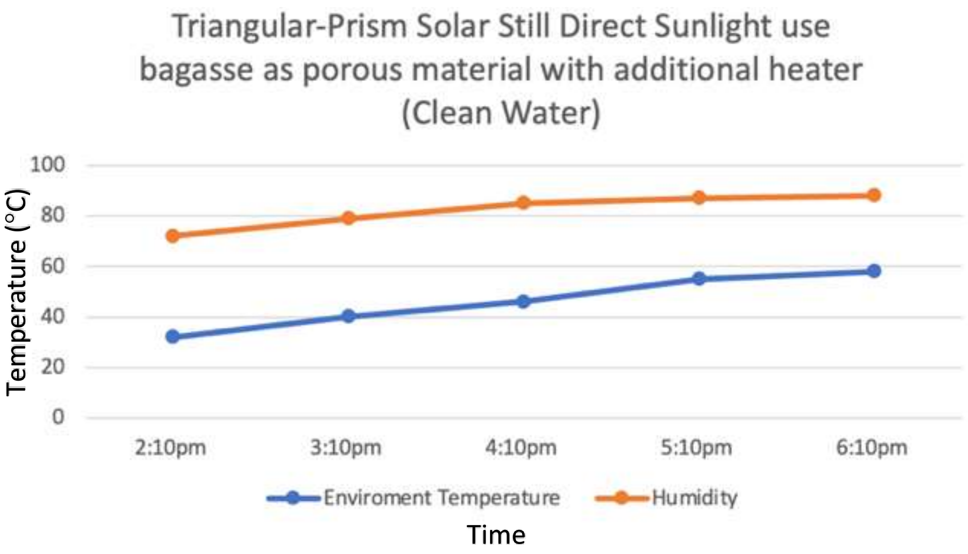

Fig. 10. Triangular-Prism Solar Still temperature and humidity analysis of PSS using Bagasse and additional heater (clean water)

During our previous test, explicitly utilizing the Peltier effect and incorporating bagasse, the heating process significantly influenced evaporation. When these two elements are combined, a substantial transformation in temperature and humidity is expected to occur, subsequently impacting the cleanliness and quality of the water produced. Regarding the technical setup, the Peltier element will be connected to the solar and battery systems to ensure a continuous and reliable energy supply. Simultaneously, the bagasse will be carefully mixed with the water within the galvanized container to explore the synergistic effects of the heating process and bagasse integration, anticipating notable alterations in temperature and humidity dynamics and ultimately influencing the quality and efficiency of the resulting clean water. Using the same TPSS setup with an additional heater as in experiment 3, experiment 4 used dirty water to investigate the performance of water production and quality. In the exact location and with the same weather conditions, this 5-hour experiment shows the following result.

The combined utilization of the heating process (utilizing the Peltier effect) and bagasse have notably impacted humidity and temperature levels, as can be referred to in Table 4 and Figure 11. It is worth noting that the temperature reached in this particular test is lower than that observed in the third experiment. This disparity can be attributed to bagasse within the experimental setup, as its inclusion has moderated the overall temperature dynamics. On the other hand, regarding humidity levels, this test has demonstrated the highest recorded values compared to all other tests. This can be attributed to the synergistic interaction between the heating process and the bagasse, wherein the porous structure promotes increased evaporation by facilitating enhanced contact between the water and the surrounding environment. This increased surface area enables a more efficient and accelerated evaporation process. Consequently, the clean water production in this test exceeded the third experiment, suggesting enhanced effectiveness in producing clean water was faster. Despite the pH value of the clean water produced in this test measuring at 6.74pH, it is crucial to note that the water remains within the range set by the World Health Organization (WHO) for clean and safe water, which spans from 6.5 to 7.5 pH. As a result, the water is still considered clean and suitable for various applications.

Table 4
An experiment of TPSS using Bagasse and additional heater (dirty water)

Parameter/Time	2:10pm	3:10pm	4:10pm	5:10pm	6:10pm
Water Drop Forming	Low	Normal	Normal	High	High
Environment Temperature	33°C	35°C	40°C	46°C	54°C
Humidity	73%	76%	80%	84%	89%
Heater Support	Yes				
Water Collected	None	Start drop	Start drop	Start drop	Almost 100ml
Water Quality	8.22pH	None	None	None	6.74pH

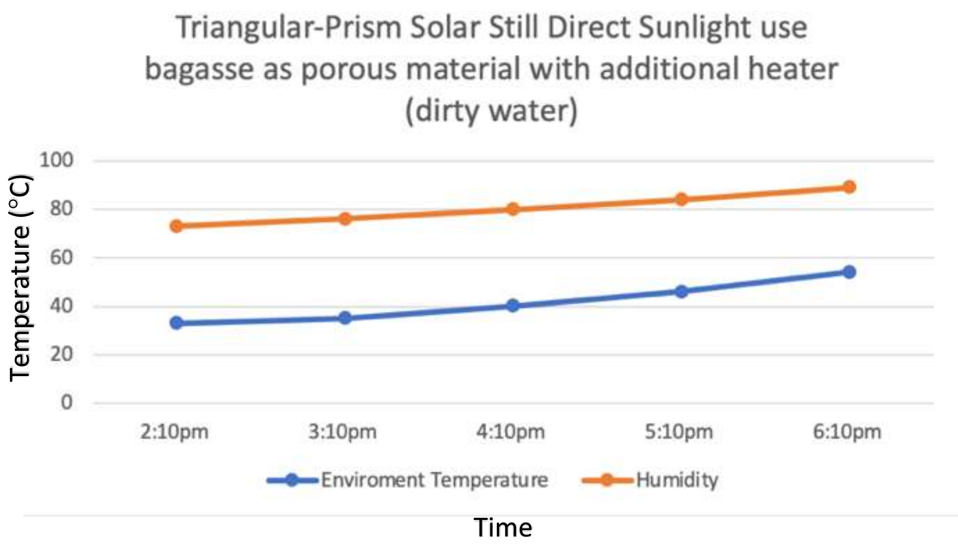

Fig. 11. Triangular-Prism Solar Still temperature and humidity analysis of TPSS using Bagasse and additional heater (dirty water)

Based on the results of the entire experiment, as summarized in Table 5, the TPSS using porous material with Peltier assisted shows the best performance when using a clean water sample compared to dirty water. Because of impurities and boiling point elevation, clean water can be processed quicker than dirty water, resulting in 1.8% better. Dirty water takes longer to reach the boiling point and starts evaporating, so water droppers form slower than clean water does. In terms of heat transfer efficiency, dirty water creates a thermal barrier, slowing heat transfer from the heat source to water. Clean water has a smoother surface, which allows better heat exchange and fast evaporation and requires less energy to reach latent heat phases due to its purity.

Table 5
Performance result for all experiments

Parameter	TPSS Experiments Results (5-hour experiment)			
	Experiment 1: Default setup	Experiment 2: Bagasse Only	Experiment 3: Bagasse & Peltier (Clean Water)	Experiment 4: Bagasse & Peltier (Dirty Water)
Average Environment Temperature	32.4°C	33°C	46.2°C	41.6°C
Peak Temperature	34 °C	34°C	58°C	54°C
Average Humidity Level	70.2%	74.6%	82.2%	80.4%
Total Water Volume Collected	80 ml	86 ml	98 ml	90 ml
Water Quality	7.7	7.7	7.4	7.4
TPSS Performance	Low	Medium	Higher	High
Water Droplets	Few	Some	A Lot of	Much

4. Conclusion

In conclusion, this study found that using clean water as a sample on TPSS with Bagasse and Peltier's assistance yielded better results than using dirty water. However, using dirty water in this TPSS can be considered to process clean water for inland areas or water scarcity areas. Based on the findings of several experiments that have been carried out using this TPSS model, some conclusions can be published. Although those experiments took longer time to accomplish due to uncertain weather conditions and inconsistent light intensity, this experiment could only be taken for 5 hours for each test, which leads to the following conclusion

i. This triangular design has an appropriate gradient to promote faster clean water collection.
ii. The use of additional heaters and Phase Change Material indirectly helps promote and maintain a consistent temperature that encourages the formation of water droplets on the inner surface of the glass.
iii. Cane waste material can be indirectly applied by providing a role as Thermal Storage Material or Phase Change Material capable of absorbing and delaying heat release.
iv. Although dirty water performs poorly compared to clean water, it is still an excellent alternative to processing clean water.

In addition to using bagasse in this experiment, other environmentally friendly PCM materials, such as corn, coconut, stones, or sand, can also be considered in further experiments, giving more promising results. It would be better if the experiment could be studied during the night production when the ambient temperature outside of the solar is still lower. Clean water can be formed more often if additional heating materials such as a Peltier, Mica Thermal Pad, or PTC Heating Element are used on the water tray.

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