



The Development of an Enhanced Smart Saltwater Desalination System

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Abstract: Water is an essential resource for life. We also know that water scarcity is a huge problem that happens around the world and especially in countries that have low economies and large populations. This thesis proposes desalination system based on solar panels for enhancing the desalination process. This project aims to produce clean water from the salt water using the concept of evaporation and the result that comes from this project is to produce a desalination system that can treat salt water to clean water not just during the day but also at night. In this project, the desalination system works by solar heating which sunlight will heat the salt water in the basin to produced evaporated water and the bulb will replace sunlight during night since its capability works same as sunlight.

Keywords: Solar, desalination

1. Introduction

Water scarcity is a complex issue that slowly worsens over time. Studies have shown water is hard to come by in the Bharathapuzha river basin in Kerala, India. Therefore, there is an increasing demand for clean water caused by the growth of population and industry, especially in water-scarce areas. Other than that, there are also articles proving the facts about unsafe water source. There are 2.16% of total deaths around the world and generally it can be seen in the age group of 70+ years. In addition, the countries that have the highest in terms of number of deaths, with an average of 554710 per year, is India [1]. According to the research, two billion people, or one in four people worldwide, lack convenient access to safe drinking water, and 3.6 billion people, or 50 percent of the world's population, lack access to waste treatment services [2]. When compared to low-income nations that lack power and infrastructure to build desalination plants, it is not the same as other nations that have robust desalination plant production infrastructure [3].

So, the purpose of the project is to build a machine capable of producing clean water for daily uses and for drinking. This system also can help us to produce water more efficiently as it uses renewable energy sources. The renewable source that used in this project is sunlight. Sunlight sources are unlimited and can be found during the day. In this project, sunlight's main role is as a heat element to desalinate water and produce clean water. Then the sunlight will also generate electricity using solar cells, to charge up the battery for the lamp during the night. This project also aims to study and investigate the relationship of volume of clean water produced to temperature and humidity.

This project is about the desalination system that has been upgraded which is it can convert saltwater into clean water. This project using concept desalination which is the power of its source comes from sunlight. Other than that, this project also using solar because to make sure the desalination process can continue operate not during day only but also can function during night. This is where the power that be absorbed by solar is use where we use it to light bulb to make sure heating process can continue during night although there is no sunlight.

2. Materials and Methods

Initially, solar panel will generate energy from sunlight and the salt or unclean water will flow into the solar basin. Then for proposed heating element which is sunlight will heat water in solar basin during day which called desalination process and bulb that will replace sunlight during night, so this system can work during day and night. Then, the clean water will be produced and tested to for its purity to confirm that it is safe to use. Next, DHT11 sensor will measure the temperature and humidity in solar basin.

As shown in the Fig. 1, solar panel, bulb and DHT11 temperature and humidity sensor is used in the project. Solar panel only function is to produce electricity to power up the circuit and charge the 12V battery. Then the battery lights up the bulb during night as bulb will replace the sunlight, and evaporation of water occurs continuously. Next, for DHT11 temperature and humidity sensor is used to collect data that is placed in the solar basin, so the data of temperature and humidity in the solar basin can be collected and analyzed. The purpose of this case study is to investigate the conditions that produced the most evaporated water. After that, the function of solar basin is to keep the heat so the evaporation process can occur constantly, and the clean water from evaporation process can be extracted through the tube into clean water storage.

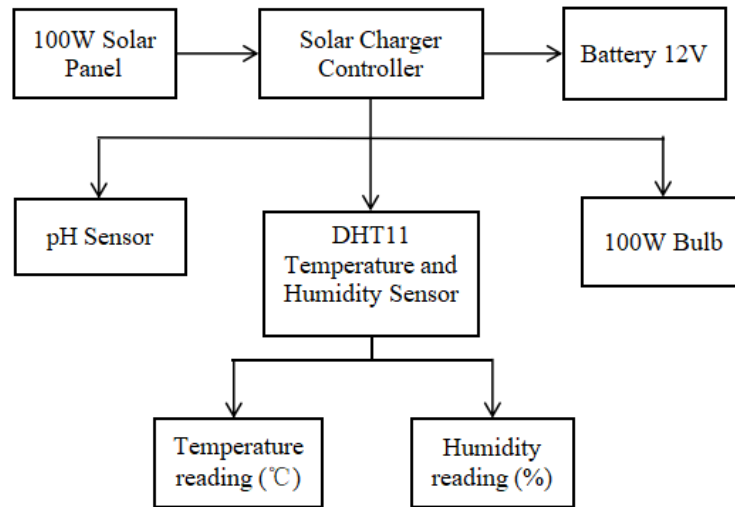


Fig. 1 - Block diagram of the system process

2.1 Materials

The tools and materials shown in Table 1 are used to measure and make the water desalination system works. In this case, all the equipment below is required for this project as has stated its function for each component:

Table 1 - List of materials used in this project

List of Components	Quantity	Function
DHT11 Temperature & Humidity sensor	1	For sensing temperature and humidity
100-Watt Solar Panel (1200*540*30 mm)	1	To generating dc electricity when particles of sunlight are knocked free from atoms
Lead-acid Battery 12V, 12Ah/20HR	2	To store electric charge from solar panel
PWM Solar Charge Controller	1	To prevents the risk of overcharging our batteries
100W Bulb	1	To replacing sunlight as a heating element during the night and day.

1000-Watt Solar Inverter	1	To convert DC current to AC current supply.
2 meters of 2.5mm Red Cable wire	1	To connect all equipment for solar system
2 meters of 2.5mm Black Cable wire	1	To connect all equipment for solar system

2.2 Methods

A good project must have good planning and methodology to make sure it is not strayed from the objectives. It took the necessary precautions to make sure this project completed effectively. This project starts with sketching the program and getting information about the components needed. This project will be divided into two sections (hardware and software) to make sure this project runs successfully.

The flowchart shown in Fig. 2 is the project implementation process step-by-step. It begins with research on parameter for Solar Desalination System (SDS) and identify what improvements can be made. Then, the design of this project with entire set of components used in this system has been carried out. As a result, the hardware can be constructed. Next, Arduino IDE is used to integrate DHT11 sensor into the system, so the data from this system can be collected easily. Lastly, the work of taking data and analyzing the data is carried out.

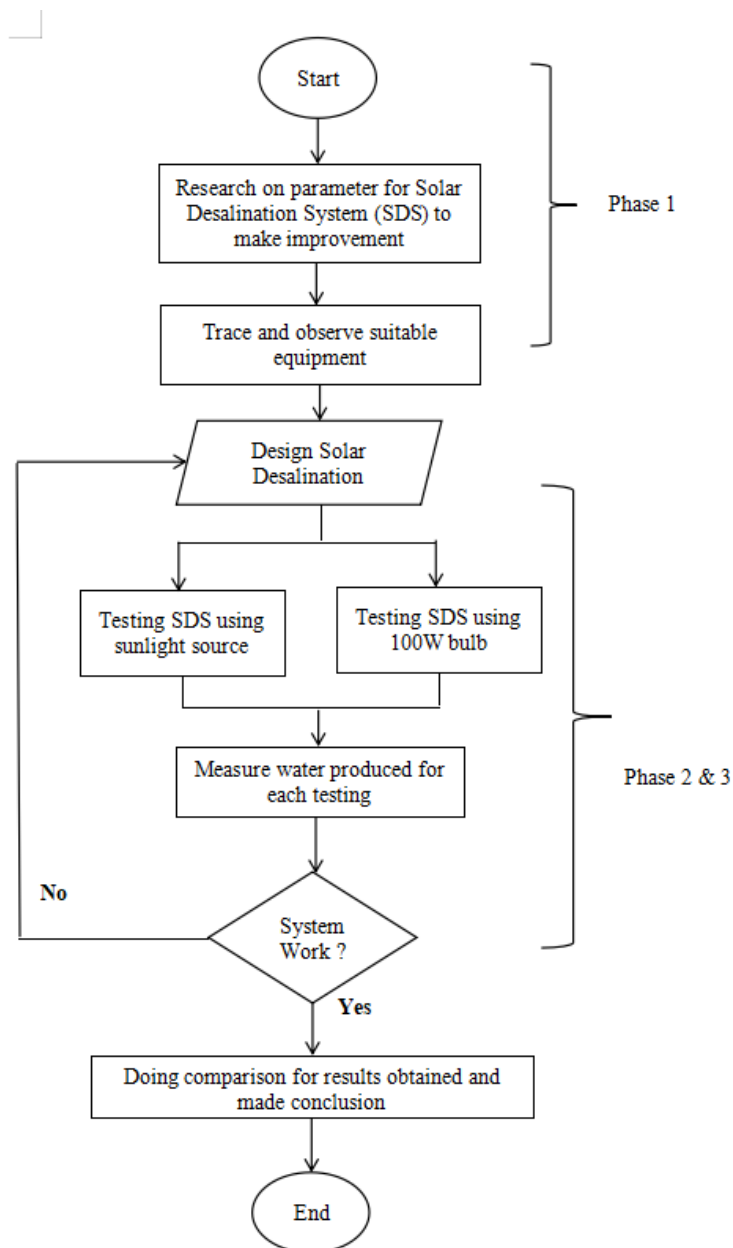


Fig. 2 - Flowchart of the system

3. Results and Discussion

First, make sure this solar desalination system must be hermetic and clean from air. This is because we want to heat the water inside the solar basin and produce evaporated water. This evaporated water will flow into the tube and goes to clean water storage. This desalination system uses sunlight as heat element, so the saltwater inside solar basin container will be evaporated when heat present. This desalination system has also been upgraded which it can also function during night because this project has added incandescent bulb that functions as heat element during night. Incandescent bulb is chosen because it produces more heat than LED bulb.

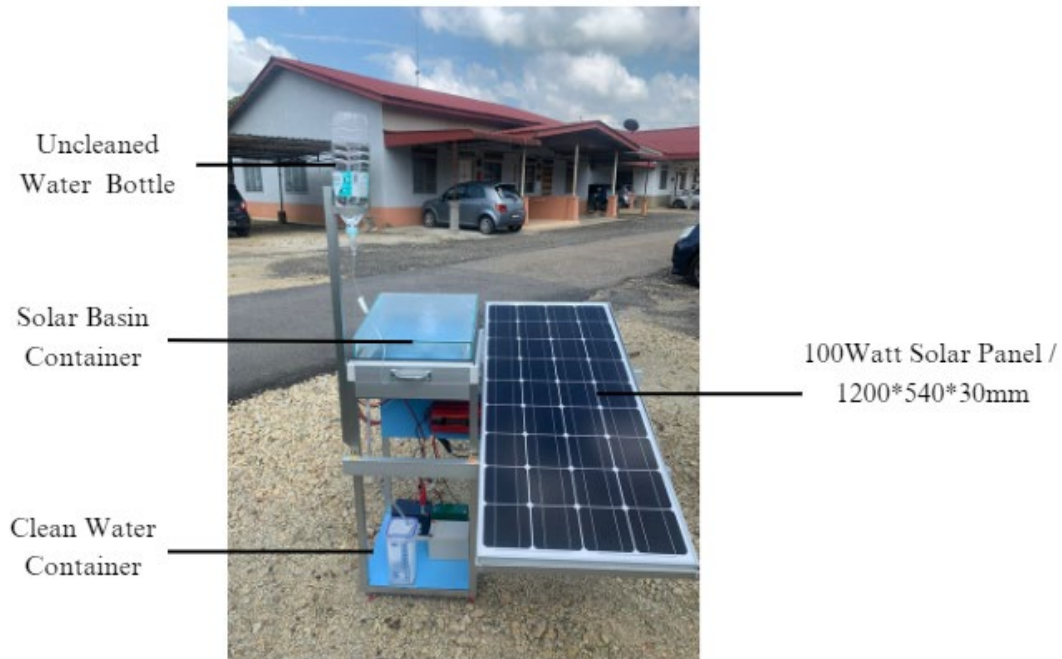


Fig. 3 - Overview of solar desalination system

3.1 Results of Evaporated Water

The result that shown for this project is that the glass can condensate evaporated water to produce distilled water by using a heat source such as sunlight. Another result has also been obtained from this project, is the usage of incandescent bulb which act as a heating element during the night to replace sunlight. Fig. 4 and Fig. 5 show the result of evaporated water that can be seen in the glass. Then the distilled water will flow through the tube to the clean water storage, and is tested for its purity.



Fig. 4 - Experiment distilled water produced during the day

Fig. 4 shows the results of evaporated water that occurs during day with sunlight as heat source of this desalination system. Here, the evaporated water condensate into clean water on top of the glass surface. It is because when water

evaporates, it undergoes a physical transformation from liquid to vapor. During this process, the water molecules separate from impurities, such as salts, minerals, pollutants, and contaminants that may have been present in the original liquid water. As a result, the water vapor produced through evaporation is relatively pure and free from many impurities.

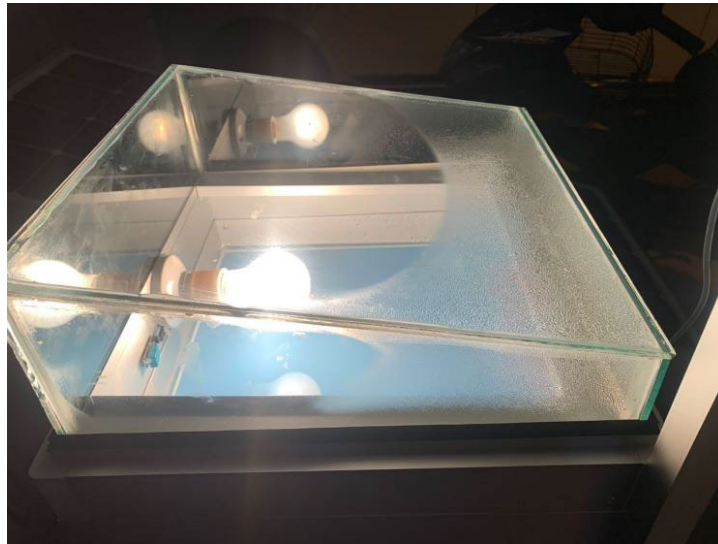


Fig. 5 - Experiment distilled water produced at night

As been shown in Fig. 5, it shows evaporated water for desalination system during night. The evaporated water produced are not efficient as the evaporated water can produced into all glass surface. This happen because of the heat supply from 100W bulb has heated the glass surface in the bulb area, therefore the glass surface cannot be optimized fully. So, the evaporated water produced here is not good compare to its working like during day.

3.2 Results Data Collection of Production Evaporated Water

For daylight, the desalination system is tested for seven hours under sunlight source to see the production of evaporated water. But for night day, the desalination system is tested for three hours by using bulb as a heating element of source to see the production of evaporated water. The data that has been collected is time (hours), temperature ($^{\circ}\text{C}$), humidity (%) and evaporated water (ml).

3.2.1 Data Collection Evaporated Water During Day

For the result obtained in Fig. 6, it shows that the volume of evaporated water depends on the temperature. When the temperature inside the solar basin is higher so more water can be evaporated. This is because higher temperature provides more energy to liquid molecules, increasing the rate of evaporation. At noon, the graph shown that evaporated water is higher which is 513.95 ml. After that, the production of evaporated water dropped because of decreasing temperature which affect the production of evaporated water. So, it can be concluded that the production of evaporated water depends on the highest temperature.

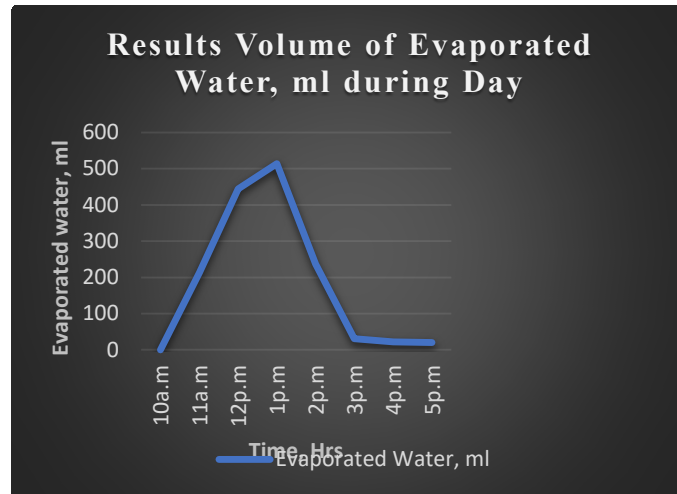


Fig. 6 - Results for volume of evaporated water during day

3.2.2 Data Collection Evaporated Water During Night

For the result obtained in Fig. 7, it shows from the graph that evaporated water is higher which is 604.74 ml. During night, bulb is used to replace sunlight to heat the water inside the solar basin. Bulb is efficient to supply heat to its surrounding because from the graph, the volume of evaporated water increases when the time period of this experiment increases. So, it can be concluded that the longer time period, the more production of evaporated water occurs during night.

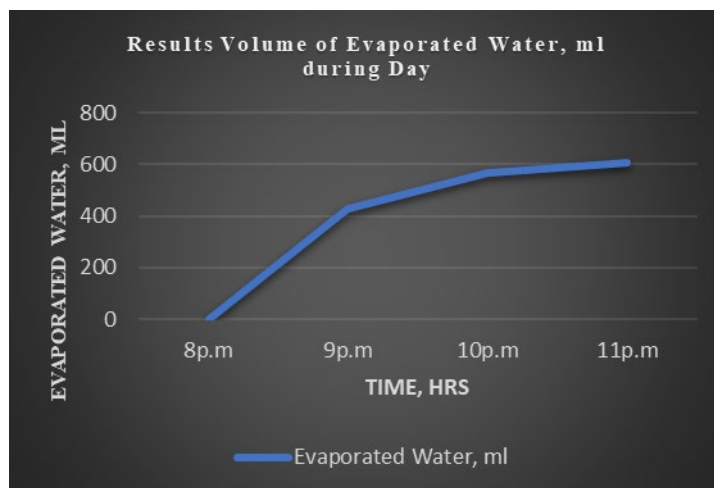


Fig. 7 - Results for volume of evaporated water during night

4. Conclusion

In conclusion, this project is very crucial and needed to be implemented in the water treatment technology all over the world due to its capability to produce clean water by using only sunlight and bulb as heating element. This project also helps poor country that has problem accessing water treatment service. Besides, this project also uses renewable energy which is solar energy that do not bring harm to our environment. Bulb produces heat to its surrounding but it did not release toxic substance or waste to the environment. So overall this project is suitable and bring more benefits for the users to help them get clean water for their daily usage.

The solar desalination system has been designed and developed successfully since it can produce evaporated water. Besides, the DHT11 sensor also are able to display the temperature and humidity in the solar basin. Here, the investigation is done to determine which temperature and humidity are able to produce higher amount of evaporated water.

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