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STUDY DIFFERENT WATER LEVEL AND PCM (DALDA AND WAX) USING SINGLE SLOPE SOLAR STILL

Suresh NATRAYAN[1] Jayaprakash RAJAN*[2] Vignesh MURUGESHAN[3]

Saravanakumar SAMI[4]

([1]Research Scholar, Research and Development Centre, Bharathiar University,

Coimbatore-641 046.Tamilnadu, India; E-mail:sureshphy.12@gmail.com

[1]Department of Physics, Hindusthan College of Arts and Science, Coimbatore-641 028), Tamil Nadu, India)

*[2] Department of Physics, Sri Ramakrishna mission Vidyalaya College of Arts and Science. Coimbatore-641020.Tamil Nadu, India; E-mail: jayaprakash.rajan.2015@gmail.com.

[3,4]Department of Physics, Hindusthan College of Arts and Science, Coimbatore-641 028), Tamil Nadu, India)

ABSTRACT

The water distillation system can purify water from any source a system that is relatively cheap portable and depends only on renewable solar energy. There are many coastal locations where seawater is abundant but potable water is not available. The rise in the temperature increases the evaporation rate and the hot air along with the moisture enhances condensation process. Here I study the rate of distillation of different water level on single Slope solar still and to study the performance of single slope solar still using PCM (wax & dalda) inside the water and compare them.

Key words: Water, solar, energy, conversion, Output, PCM

INTRODUCTION

Energy as we know is the capacity or ability to do work. As there are different forms of work, he energy required to do that work also will be in different form. It may exist in potential, kinetic, thermal, electrical, chemical, nuclear, or other various forms. For example, any moving body will have kinetic energy. A stationary object will have potential energy. Similarly, nuclear energy is potential energy because it results from the configuration of subatomic particles in the nucleus of an atom.

The purpose of this project is to design a water distillation system that can purify water from nearly any source, a system that is relatively cheap, portable, and depends only on renewable energy. The motivation for this project is the limited availability of clean water resources and the abundance of impure water available for potential conversion into potable water, In addition, there are many coastal locations where seawater is abundant but potable water is not available. My project goal is to efficiently produce clean drinkable water from solar energy conversion. Distillation is one of many processes that can be used for water purification. The accessibility of drinking healthy freshwater represents one of the main challenges facing the world these days, especially in remote and arid areas. Along with energy and food, drinking freshwater is one of the fundamental necessities for sustaining all life on earth. However, most of the available water is saline and not appropriate for drinking purposes and domestic use (1). Industrialization of societies and unsustainable consumption rates cause unbalance between the increasing demand and the provision of freshwater. Therefore, to cover this severe shortage of freshwater, water desalination is an obligatory solution. In recent years, water desalination has been performed using different techniques such as membrane distillation, multiple effect distillation, and reverse osmosis. Unfortunately, employing these desalination methods causes many problems such as fossil fuels depletion crisis, global warming, and other environmental hazards (2). Therefore, the necessity for using sustainable and renewable energy sources for water desalination is an urgent technical issue. Accordingly, utilization of solar energy as a self-sustained source for water distillation seems to be a promising way. A solar still is an inexpensive device that yields drinkable and portable water from salty water utilizing the energy from the sun. However, its low freshwater productivity is the main drawback which makes its real implementation limited (3). Recently, employing thermal energy storage units (THS) with solar distillation systems seems to be an encouraging practical solution to solve the increasing imbalance between energy provision and energy consumption (4). The application of THS in the solar stills has recently gained much attention among researchers due to its promising features. In brief, Dashtban and Tabrizi (1994) examined the performance enhancement of a weir solar still incorporated with PCM storage unit under the basin (5). Ansari et al(2001). Theoretically investigate the freshwater yield enhancement of a passive solar still incorporated with PCM storage unit (6). The authors concluded that selecting the PCM materials rely strictly on the peak temperature of saline water. The addition of a solar concentrator with a hemispherical solar still, in the presence and absence of PCM, is experimentally studied by Arunkumar et al.(2004) (7). The experimental results indicated roughly 26% increment in the freshwater yield for the still with PCM compared to a conventional one. El-Sebaii et al. (1998) analyzed analytically the yield of simple type slope still in the presence and absence of PCM. Their findings indicated that as the amount of the PCM increases, the nighttime and total daily productivities also increase, while the daytime productivity decreases (8). A solar still is modified by incorporating a solar air heater and a PCM storage unit has been experimentally evaluated by Kabeel et al.(2001) (9). Dunkle (2006) who derived a widely used as well as analyzed , semi empirical relation for evaluating the internal Heat and mass transfer within solar distillation units (10). Malik et al(2001) .then summarized a historical review on solar distillation systems, Tiwari and Lawrence attempted to incorporate the effect of inclination of the condensing surface using the same values of C and n as proposed by Dunkle. (11). Kumar and

Tiwari(1995) developed a thermal correlation for outdoor conditions based on linear regression analysis to determine convective mass transfer for a varying range of Grashof numbers (12).

CONSTRUCTION

The setup consist of inner system and an outer system. The materials required for the setup are sawdust, beaker paint, water, wax, dalda, glass, thermocoal, steel. The passive solar system is used in this experiment that is only the solar heat is supplied to the system and no other external source is used to supply heat to the system. First the innersystem is constructed.

The material used in this construction is the Japanese steel and the thickness is 18 kg, length is 75cm,breadth is 50cm, height are 45cm and 25cm.The slope is 15degree 76cm,50cm.After the completion of its construction it is painted black completely.

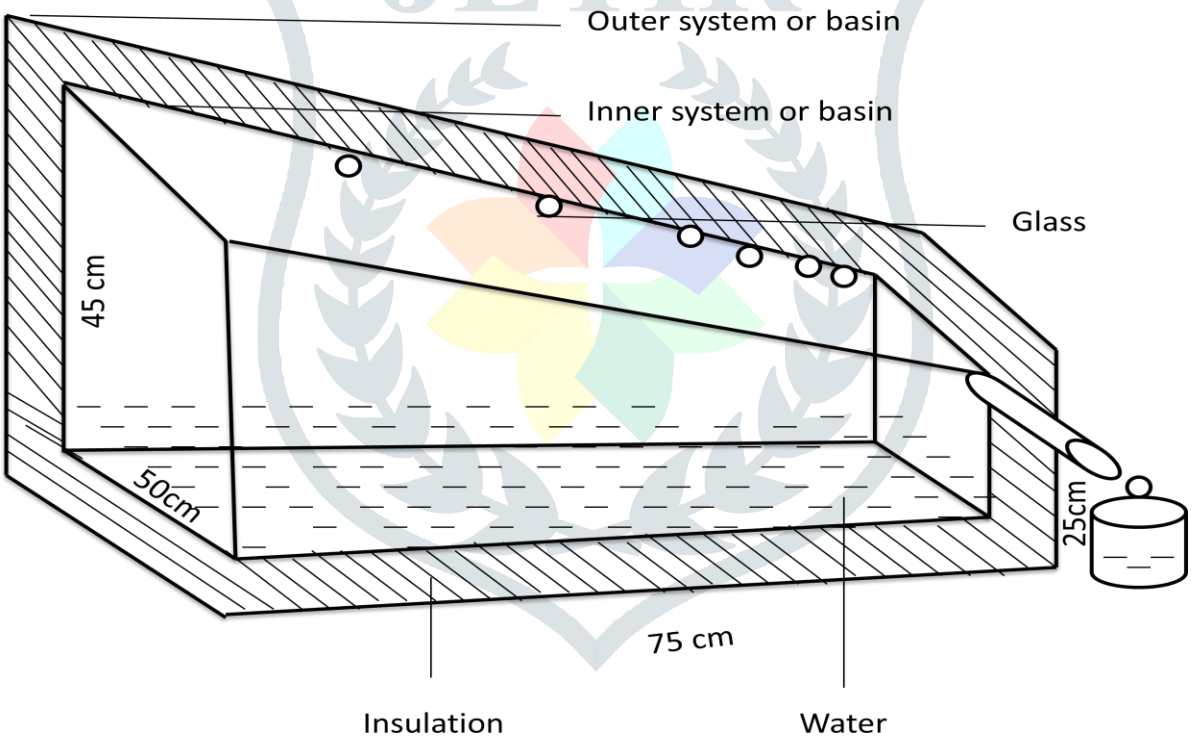

FIGURE 1: CROSS SECTIONAL VIEW OF SINGLE SLOPE SOLAR STILL

FIGURE 2: IMAGE OF SINGLE SLOPE SOLAR STILL

The purpose of this is to absorb more radiation. Then the outer system is constructed. Steel is used in the construction of outer system. The weight of outer system is 24kg.The length is 85cm, breadth is 60cm, height 50cm and30cm and the volumeis153 litre. Then the insulation is done in order to prevent the heat loss from the system. Sawdust is used for insulation with 5cm thickness. This insulation is done inside the outer system. After this insulation the inner system is placed inside the outer system. The thickness of glass used is 3mm and the length is 49cm.Thermocoal is used to seal the gap between inner system and outer system.

WORKING

The working of experimental setup is checked by Conducting trials. Then the actual experiment is carried out by pouring 10litres of water in to the system. For every half an hour the reading is taken from 9AM to 4 PM. After that reading is taken from 4PM to 9AM.Then The distilled water is measured. For the second time 15 litres of water is poured in to the system. The same procedure is repeated. After this a steel pipe of 28cm which is filled with wax of 2 ordinary candles in which two ends are sealed with M seal is placed in the inner system. Then 10litres of Water is poured in to the inner system. The reading is Taken for 24 hours. The same procedure is done after Replacing wax with 100ml dalda. The readings are taken By repeating the experimental procedures. The values are then compared and studied.

RESULTS AND DISCUSSION

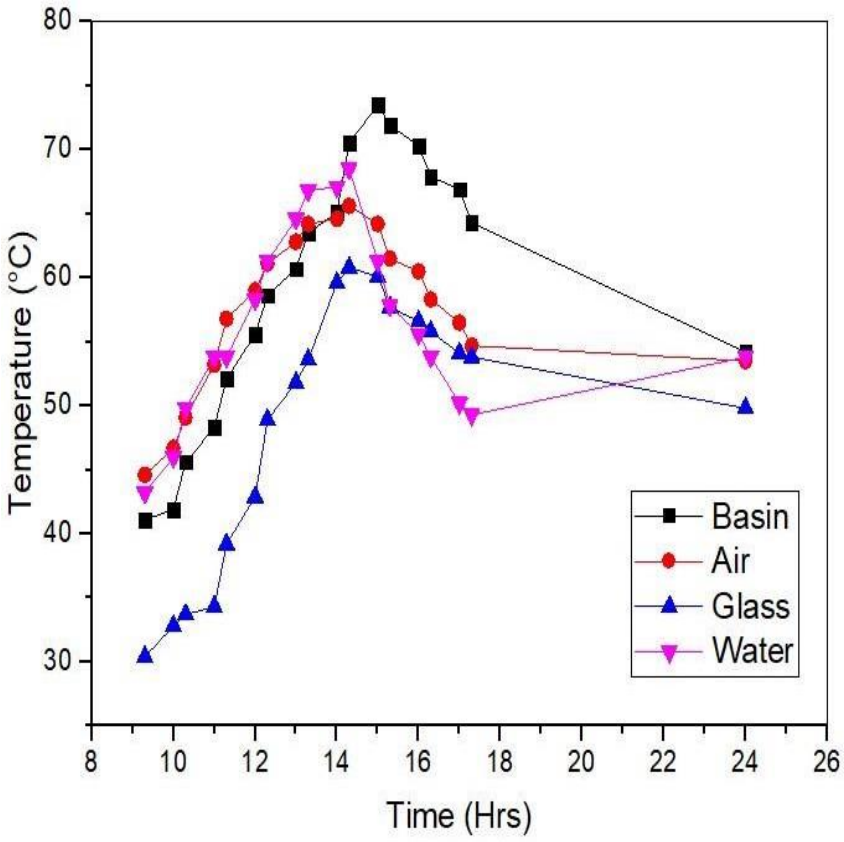

FIGURE 3: DIFFERENT WATER LEVEL (10L WATER WITH DALDA)

The above table and graph represent the readings taken on 25/04/2022, Monday with an average temperature of 34-24 degree Celsius using 10 liters of water.

During this study, the ambient temperature of air was in the range of 44.6°C and 65.6°C, water in the range of 43.2°C and 67.5°C, basin material 41.1°C and 73.5°C and glass it is from 30.4°C to 60.8°C.

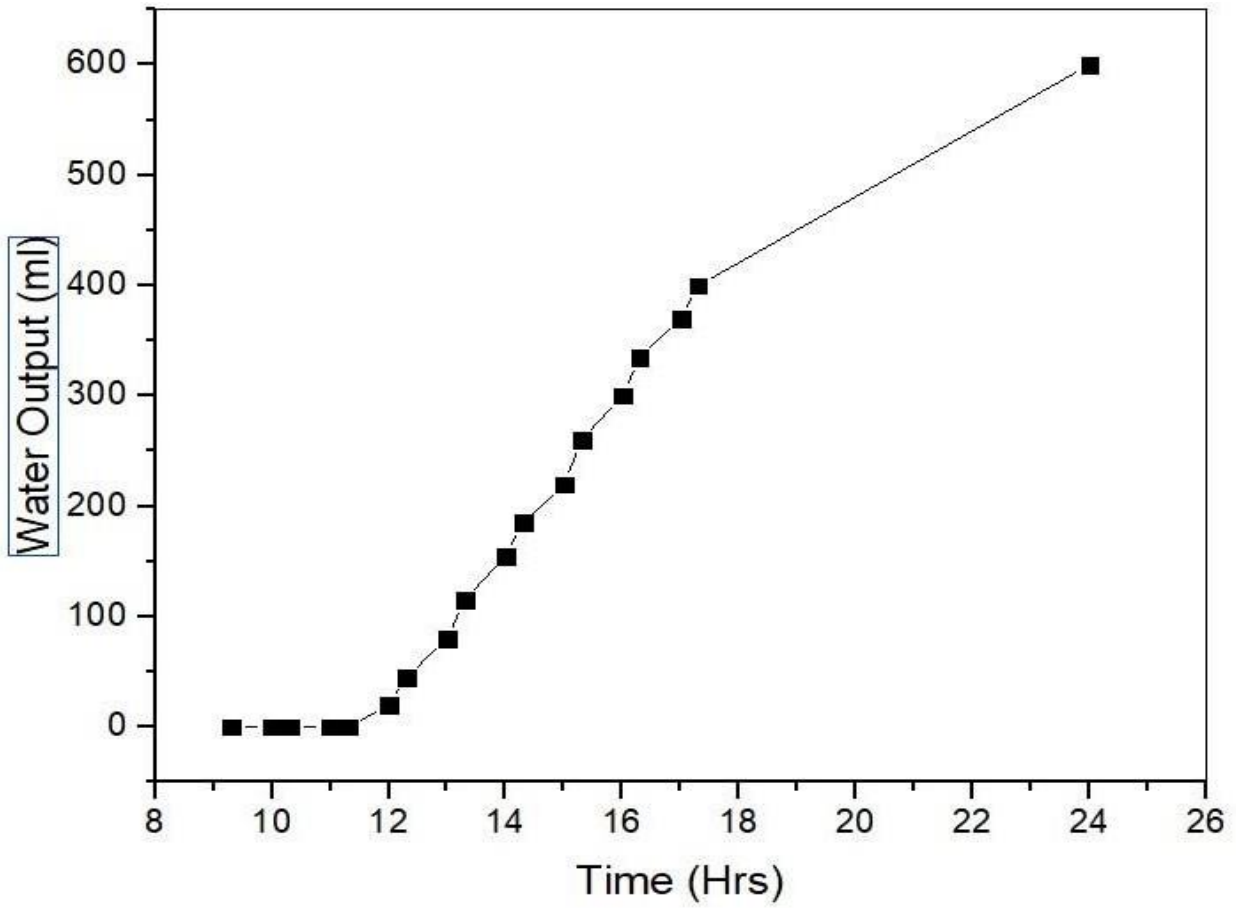

FIGURE 4: WATER OUTPUT (10L WATER WITH DALDA)

The average temperature rise would affect the condensation hence resulting in the difference in output. The output received during the daytime was 400ml.

The output received during the night time was 200ml. The total output received was 600ml.

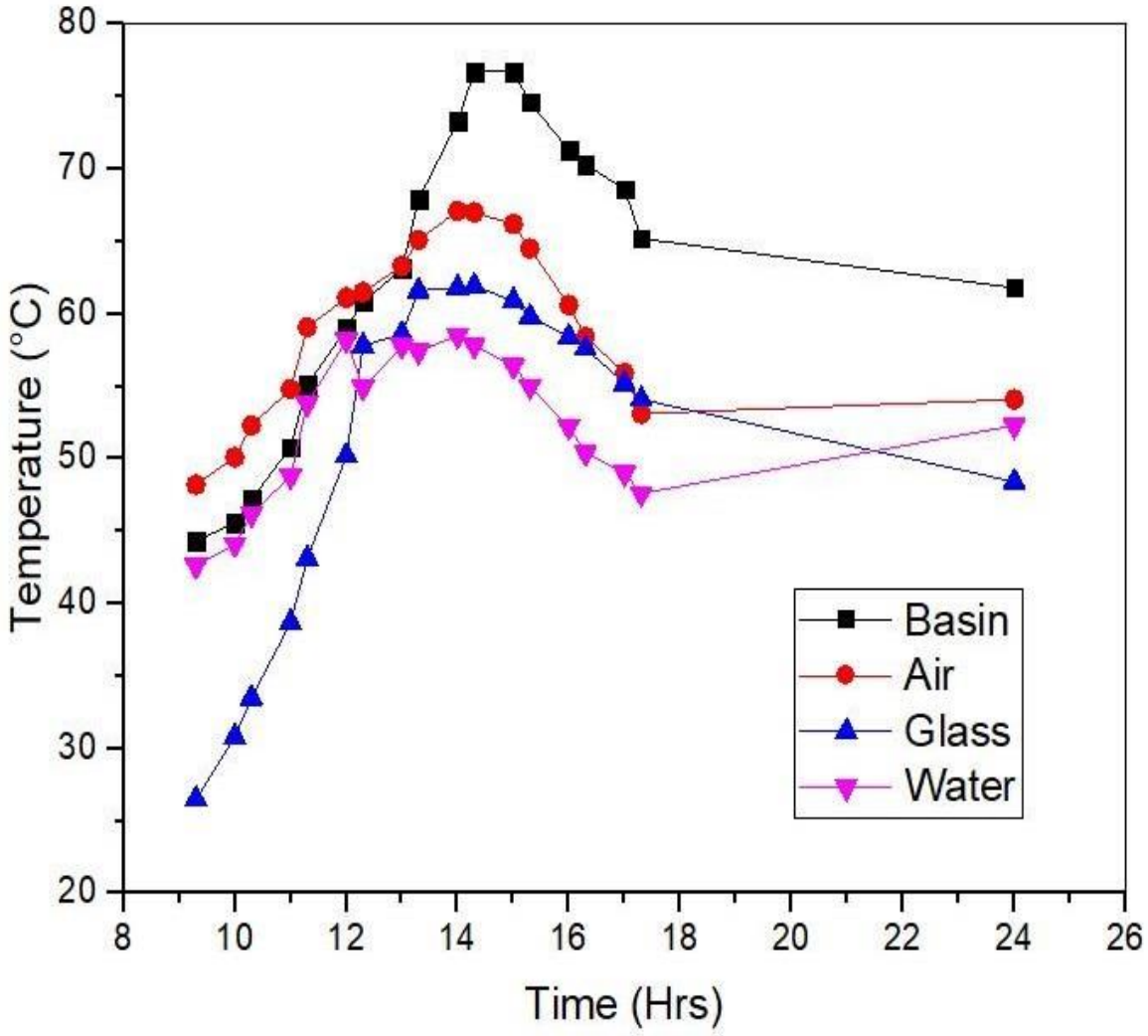

FIGURE 5: DIFFERENT WATER LEVEL (15L OF WATER WITH DALDA)

The above table and graph represent the readings taken on 28/04/2022, Thursday with an average temperature of 34-24-degree Celsius using 15 liters of water.

The highest temperature rise in water was 58.5°C and air was 67.1°C. During this study, the ambient temperature of air was in the range of 48.2 and 67.1°C, water in the range of 42.6°C and 58.5°C, basin material 36 and 65 and glass 26.5 and 61.9°C.

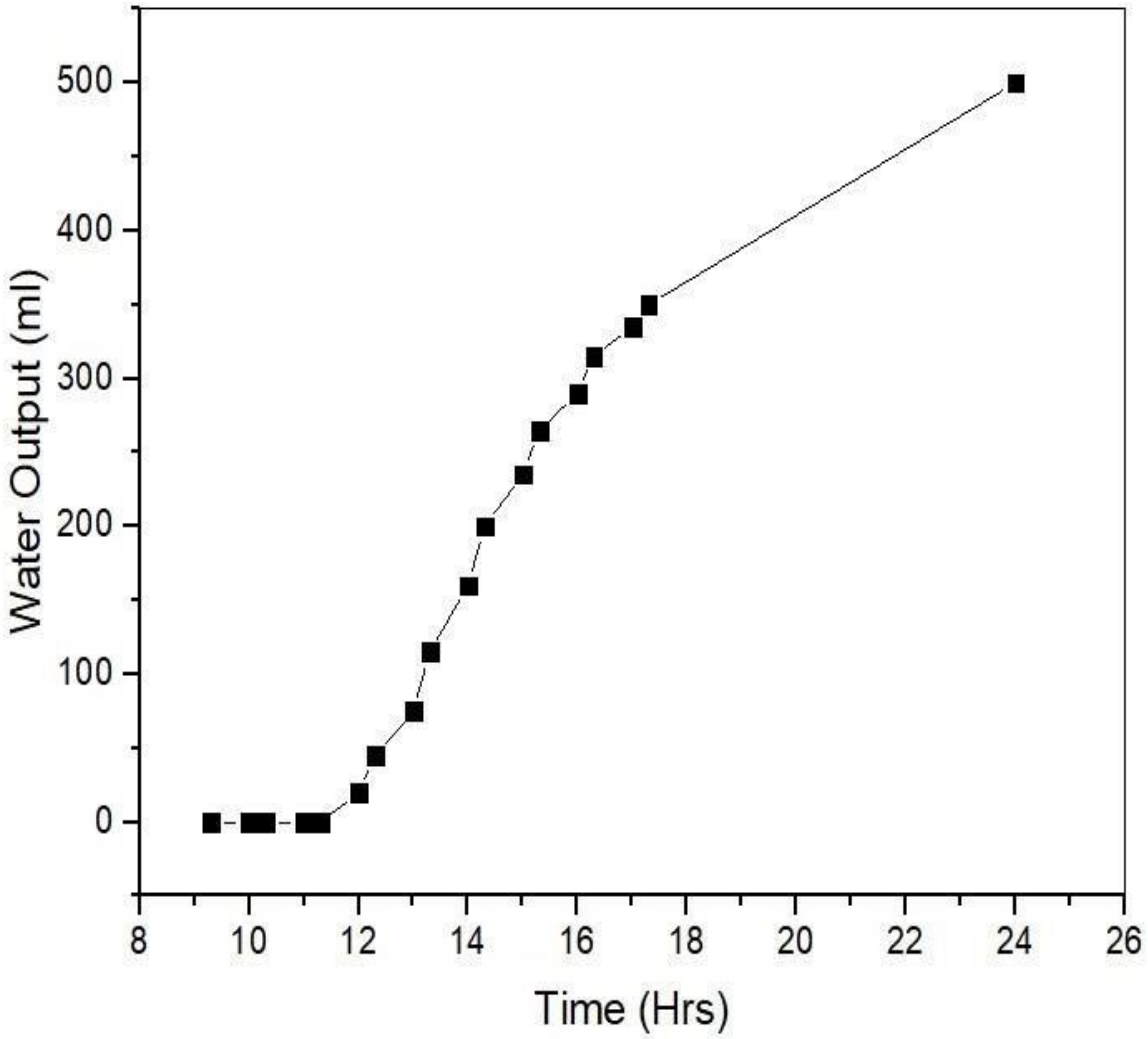

FIGURE 6: WATER OUTPUT (15L WATER WITH DALDA)

The output received during the daytime was 350ml. The output received during the night time i.e., the time between 04.00PM and 09.00AM was 150 ml. The total output was 500ml.

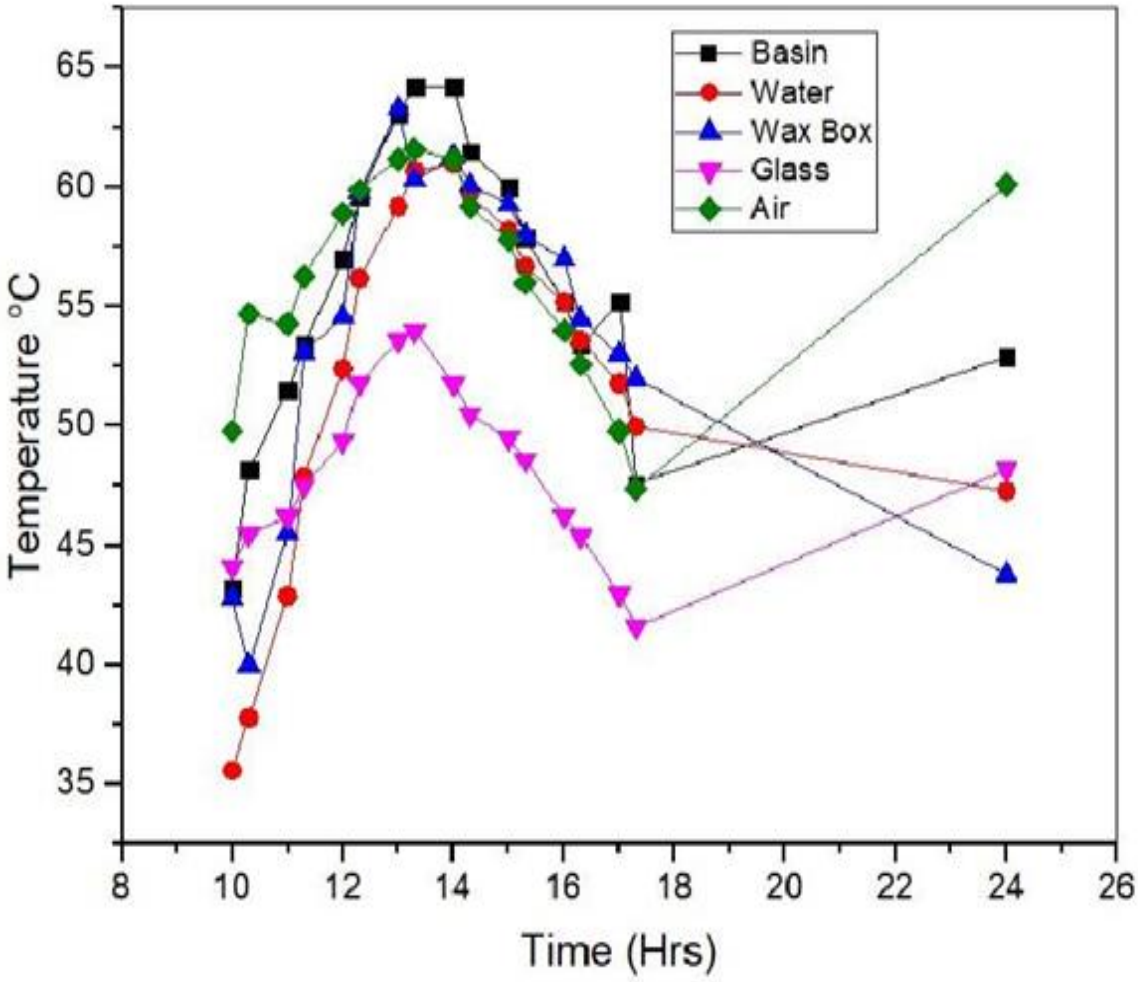

FIGURE 7: DIFFERENT WATER LEVEL (10L OF WATER WITH WAX)

The above table and graph represent the reading taken on 30/04/2022, Saturday with an average temperature of 25-35ºC using 10 liters of water. The highest temperature rise in water was 61ºC and air was 61.6ºC.

During this study, the ambient temperature of air was in the range of 49.8and 61.6ºC, water in the range of 35.6 and 61ºC, basin material 43.2ºC and 64.2ºC and glass 44.1ºC and 54ºC.

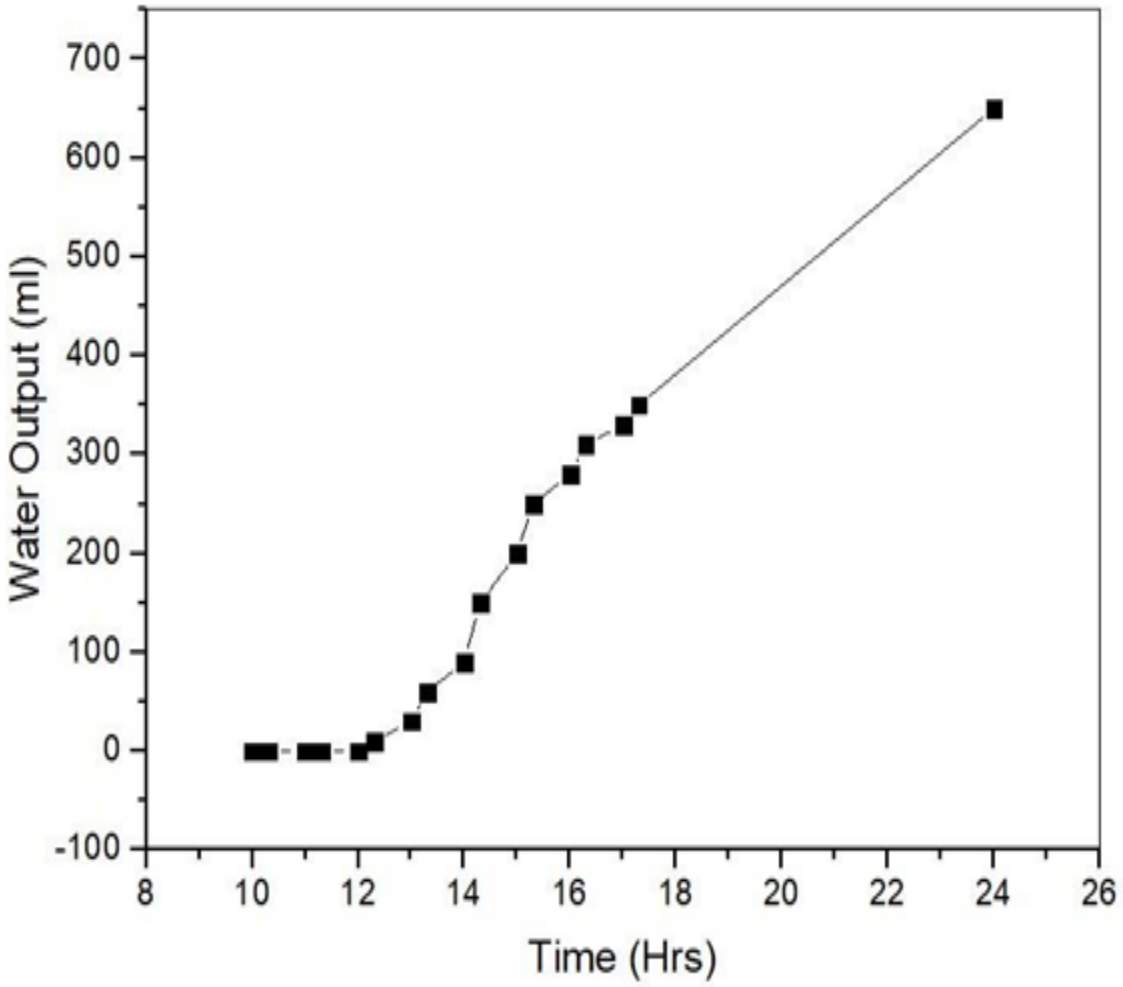

FIGURE 8: WATER OUTPUT (10L OF WATER WITH WAX)

The total output received from 9 AM to 4 PM is 350ml and from 5.30 PM to 10AM is 330 ml and the total output is 680ml.

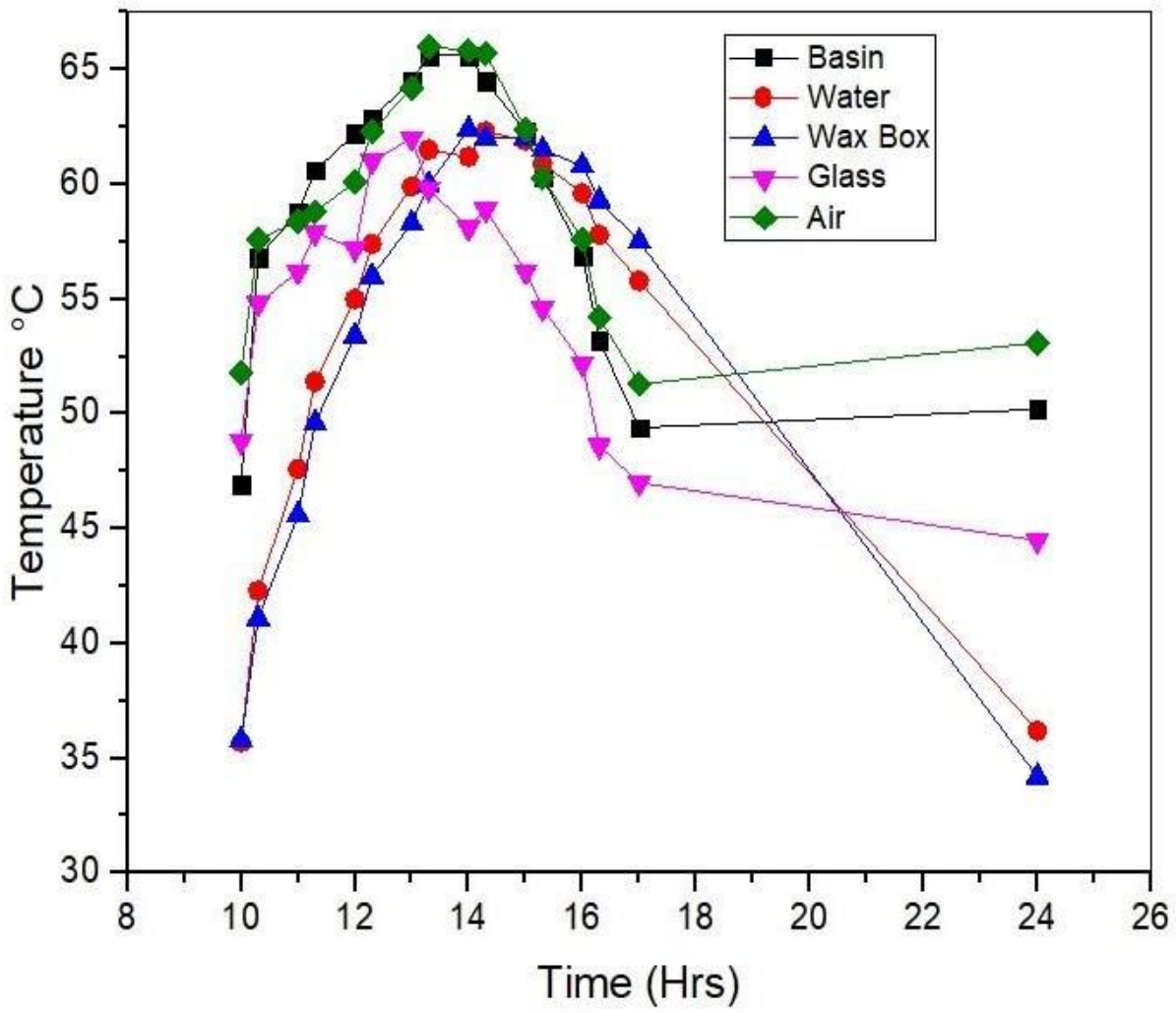

FIGURE 9: DIFFERENT WATER LEVEL (15L OF WATER WITH WAX)

The above table and graph represents the readings taken on 3/05/2022 , Monday with an average temperature of 33 – 25 ºC using 10 litre of water.

The highest temperature rise in water was 61.9ºC and air was 66 ºC .During this study, the ambient temperature of air was in the range of 51.8 – 66 ºC, water in the range of 35.7– 61.9ºC, basin material 46.9 – 65.6ºC and glass 48.8– 62ºC.

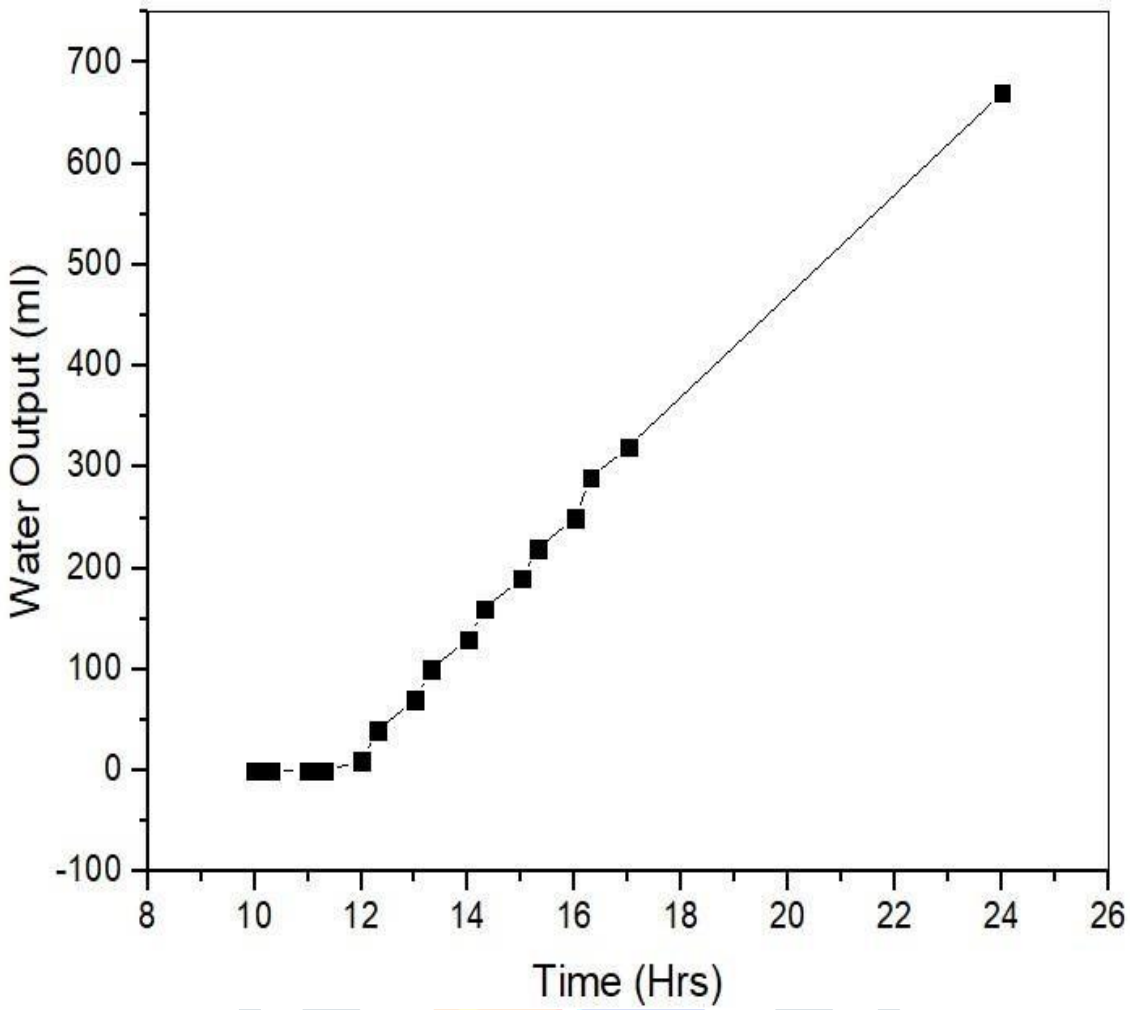

FIGURE 10: WATER OUTPUT (15L OF WATER WITH WAX)

The total output received from 10 AM – 5 PM is 320ml and from 5 PM – 10 AM is 350 ml.The total output is 670ml.

CONCLUSION

The melting point of Dalda (Vanaspati) is 31 ºC -41 ºC and the melting point of the Wax ranges from 46 ºC -68 ºC. Since for this melting temperature of these materials they are used as (PCM) at different water level. As a result, the PCM (Wax) used in single slope solar still and we got 670 ml and by using the PCM Dalda in single slope solar still is 600 ml. Hence, the Wax has the highest retaining heat capacity it vaporizes the most of the water and we got the maximum output than the PCM Dalda (Vanaspati).

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