AN EXPERIMENTAL STUDY OF SINGLE BASIN DOUBLE SLOPE SOLAR STILL

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Abstract:A Double slope solar still is a widely used solar device for converting available saline water into potable water. This device can be a suitable solution to solve potable water problem as it can be fabricated easily with available materials,with the intention of providing a simple cost solution to the potable water problem.In this paper,an attempt has been made to study experimentally about the productivity of single basin double slope solar still with different concentration levels of salt in the water.The aim of this research has been to study the effect of the double slope single basin solar still with different salt level concentration and solve potable water crisis by creating a durable apparatus which is cheap to manufacture and to buy,which can last for long time in any weather conditions and which can be detachable so that it can be mounted anywhere.

I.INTRODUCTION

Water is necessary for all plants, animals and humans. Water covers around 70% of the earth's surface. About 97% of the water on earth exists as the salt water in the oceans and the remaining is the water in the form of ice contained in the frigid zones, groundwater, lakes and rivers. These sources furnish most human and animal needs. Only about 1% of fresh water is available for human use. Even this small fraction is believed to be adequate to support life and vegetation on earth. Most of the fresh water comes from the hydrological cycle, which itself is a very large-scale process of solar distillation to produce fresh water. However, rapid growth of population and industries worldwide has resulted in an exponential growth in the demand for freshwater, both for domestic and agricultural purposes. Solar stills have the potential to provide desalinated water with minimal cost in coastal areas since it uses renewable solar energy and efficient components. Desalination is the process that takes away mineral components from saline water. More generally desalination refers to the removal of salts and minerals from a target substance.

Bharath kumarpatilhas studied the maximum productivity of a double slope single basin solar still was obtained when black pebbles was used. This is comparatively low when there were no pebbles used and found to be increase in the productivity by 75 ml per hour. The productivity of the still can be enhanced by varying the inclination angle of the glass cover. This help us to make use of pebbles in our present experimental study.

B. N. Subramanian enhanced the productivity of double slope single basin solar still by use of phase change material and also found that the heat loss was reduced. So that we compare the phase change material [paraffin wax] with thermocol and found that the property of thermal resistivity was more.

R. Samuel had conducted the experimental analysis on a double slope solar still coupled with fin shaped absorber with basin area 1m x 1m. The overall productivity in the integrated still with fin shaped absorber was increased by 47%. This experimental study helped us to selection of the absorber area in the current experimental study

Singh et al had analyzed the orientation for inclination of glass cover for higher yield in the double slope solar still and also overall thermal efficiency and internal heat transfer coefficient have been also investigated. This analysis helps us in enhancing the orientation of the glass cover and the rate of flow of condensed water which have been collected at the inner surface of the glass cover has been improved.

Tiwari et al had studied experimentally that the increase in collector area decrease the instantaneous thermal efficiency of the solar still. This experimental study helped us in selection of collector area where the larger collector area reduces the volume of water collected as it requires more time to evaporate, where as in smaller collector area needs less time to evaporate.
T. Rajaseenivasan and K. KalidasaMurugavelhave carried out experiment and concluded that the water depth plays a role in production rate. When the basin water depth is minimum the heat transfer was more and the volume of water collected increased. This helped us to maintain the water depth to be minimum so that the heat transfer was more and improved the productivity.

Vast of research had been conducted in this area and there where improve in productivity by using the different materials inside the basin such as pebbles and pin fins and also provide us to maintain proper inclination of glass cover that improves the flow rate of condensed water, the productivity is also been improved by maintaining the water depth. In this project we use solar energy for desalination process which is abundance in nature. In this project focus is given to create durable apparatus which is cheap to manufacture and perform experimental study on the desalinator.

II. Materials and Experimental Methods:

Design of solar still

Outer casing:

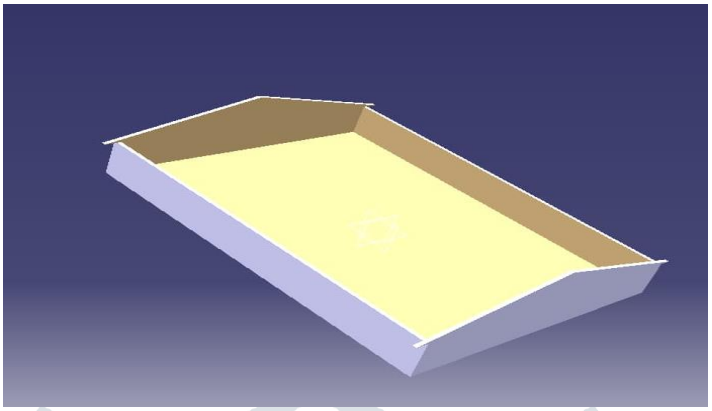


Fig -1: **Wooden box casing of 10mm thick plywood**

The Wooden box is the outer casing of the solar still made up of plywood which acts as a thermal insulator helps in retaining the heat absorbed by the water. Hence, leads to the increase in the rate of evaporation of the water poured into the solar still in the form of salt water. It is also easily available and fabrication is easy.

Aluminum container:

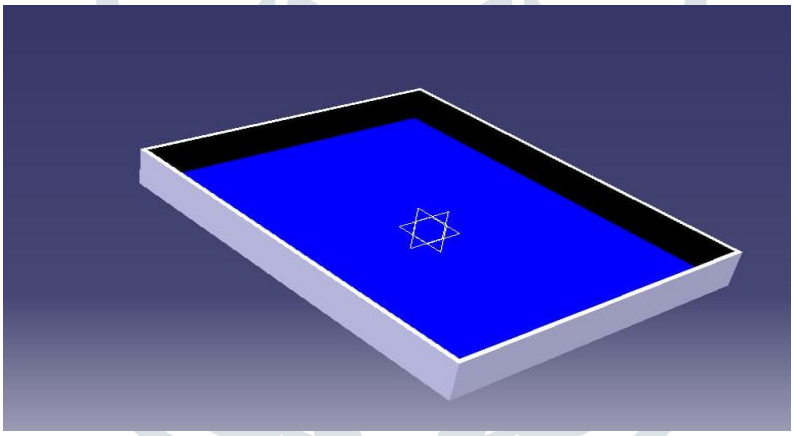


Fig -2: **Absorber with aluminum bottom coated with black paint.**

Aluminium plate is used as a heat storage material as it has thermal conductivity (205 W/m-K) and also has a good corrosion resistance. It is coated with black paint to absorb more radiations. The top cover of the wooden box is taken as glass as it allows more amount of solar radiations to pass inside the solar still and increases the absorption of solar radiations by the aluminium plate.

Glass cover

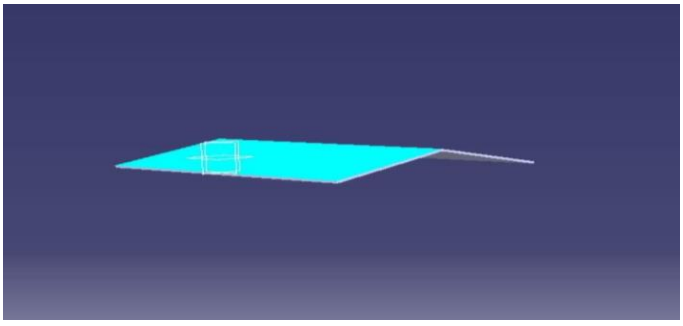
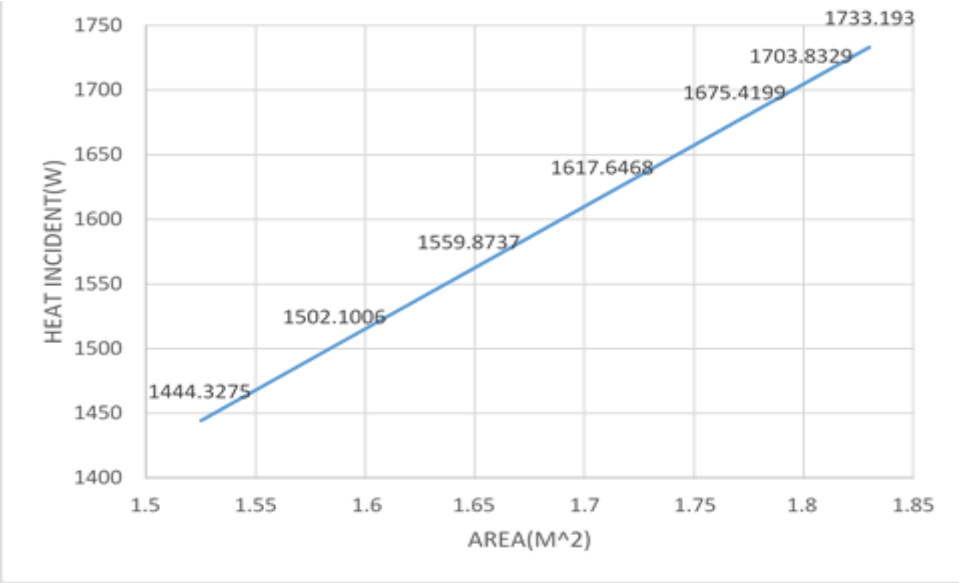


Fig -3: Glass top cover

The top cover of the wooden box is taken as glass as it allows more amount of solar radiations to pass inside the solar still and increases the absorption of solar radiations by the aluminium plate.

Calculations

Column1	Column2	Column3	Column4	Column5
Solar constanat	Area*feet	Area	Multiplication factor	Heat incident
w/m^2		m^2		w
1353	2*2.5*0.305	1.525	0.7	1444.3275
1353	2*2.6*0.305	1.586	0.7	1502.1006
1353	2*2.7*0.305	1.647	0.7	1559.8737
1353	2*2.8*0.305	1.708	0.7	1617.6468
1353	2*2.9*0.305	1.769	0.7	1675.4199
1353	2*2.95*0.305	1.799	0.7	1703.8329
1353	2*3*0.305	1.83	0.7	1733.193



As the above graph represents the selection criteria for the area required to develop the solar still. Hence the graph shows that as the area of solar still increases comparatively the efficiency is also increased and vice versa. So we have been considered the highest parameter according to the needs, the parameter is expressed in terms of [Area x Feet] that is 2 x 3 m^2 for which the heat incident of 1733.193W which impacts the highest efficiency upon the still based on the graph been plotted

FABRICATION

Outer casing and Basin

Length of casing: 94 cm
Width of casing: 74 cm
Height at the host: 18.6 cm
Thickness of casing: 1.5 cm

Fig -4: outer casing and basin Specification of wooden box

Length of basin=70 cm
Width of basin= 90 cm
Height of basin= 10 cm
Thickness of basin= 0.1 cm

It is the part of the system in which water to be distilled is kept. It is therefore essential that it must absorb solar energy Hence, it is necessary that the material has high absorptivity or very less reflectivity and very less transmittivity. These are the criteria for selecting the basin materials.

Glass cover

Fig -5: glass cover

Length of glass cover: 94 cm
Width of glass cover: 74 cm
Thickness of glass cover: 0.5cm

The use of glass is because of its inherent property of producing greenhouse effect inside the still. Glass transmits over 90% of incident radiation in the visible range.

Measuring Device

Measurement of Temperature: The Digital Mini LCD Temperature Thermometer with Probe sensors are used to measure the temperatures at various locations of the still. For measuring the water vapour temperature, the one sensor is used. The range of this temperature sensor is from -50°C to 110°C.

Working model

Fig-6: Working model

Solar still is made of a single-basin with a black painted aluminum absorber at the bottom which contains sea water. This is enclosed in an insulated chamber formed by a transparent glass cover which is sealed to prevent heat loss. Incident solar radiation passes through the transparent cover and is absorbed by the black aluminum plate. Heat transfer takes place from absorber plate to the water. Consequently, water contained in the basin gets heated up and evaporates slowly. Water vapor rises up and condenses on the inner surface of the glass cover. The condensed water flows downwards along the glass cover bottom surface because of gravitational force and is collected using water collector which is placed above the surface water level. Thermometer is used to measure glass cover and water temperature. Water volume is measured using a measurement glass jar.

Results and Discussions

The experiment is conducted by measuring the volume of water collected using measuring jar, time of the day, temperatures of the glass and water inside the basin and the different trails are processed by keeping the solar still in a sunny day from morning 10:00AM to 4:00PM, there by the experiments are conducted as follows.

Fresh water

The graph represents the volume of water collected at the time of the day is 2750 ml of water was been collected for the charge of 5000 ml. Since it being a fresh water volume of water collection is maximum. Thus the graph indicates lesser the salt concentration higher the water volume collection.

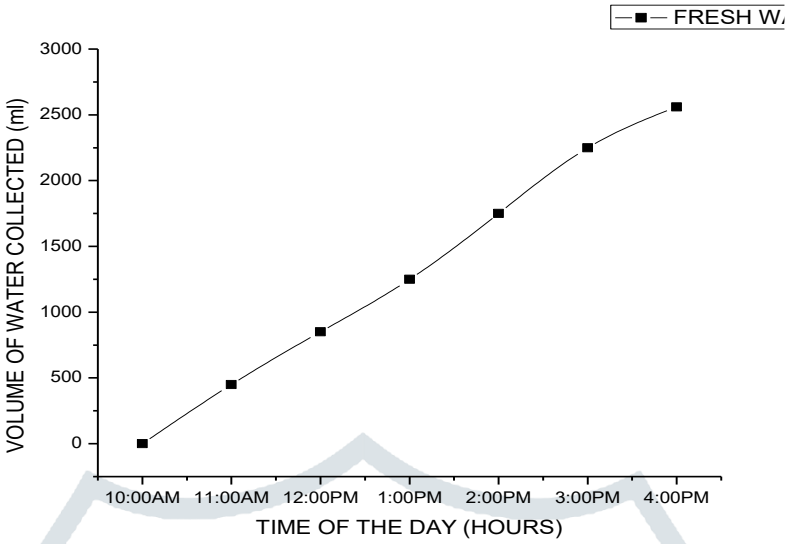


Fig- 7: Volume of water collected vs time of the day when fresh water is used

Different concentration of salt

Basically the percentage of salt content in the sea water is 3.5%. The Fig-8shows the volume of water collected at different time of the day for different salt concentration as you can see in the graph the volume of water collected is maximum for lesser salt concentration that is 1.5% than that of higher salt concentration that is 3.5%. The Fig-8also shows volume of water collection is higher in lesser salts concentration in water.2250 ml of water collected at the end of the day i.e, 4pm for the salt concentration of 1.5%.1800 ml of water collected at the end of the day i.e, 4pm for the salt concentration of 2.5%.1650 ml of water collected at the end of the day i.e, 4pm for the salt concentration of 3.5%.

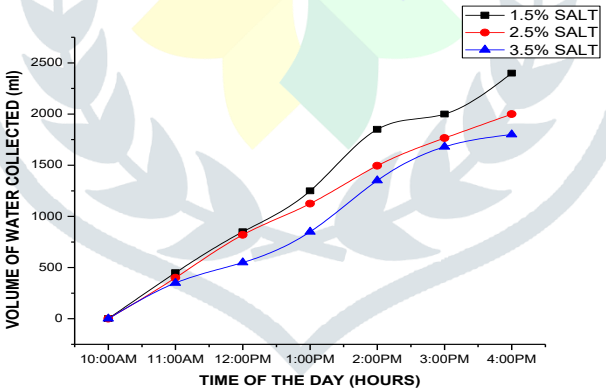


Fig- 8: Volume of water collected vs Time of the day for different salt concentration

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With and without fins

Fig-10 shows the volume of water collected at time of the day with the presence of fins and without fins.
2500 ml of water is collected at the different time of the day i.e, 4pm for both with and without fins.

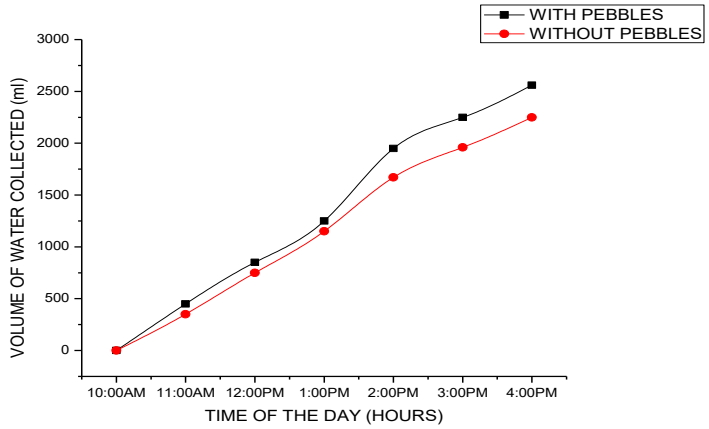

Fig- 9: Volume of water collected vs Time of the day with and without the use of pebbles

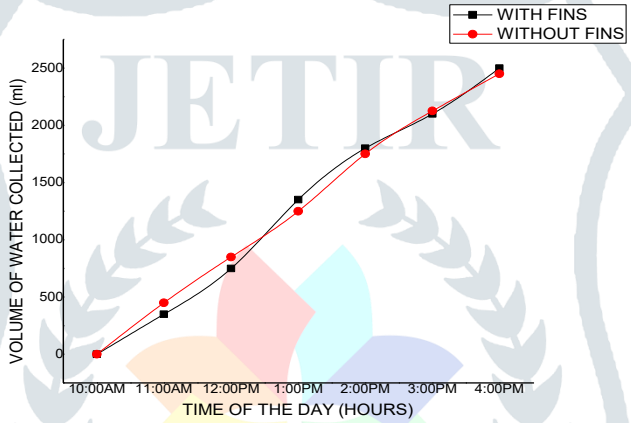

Fig- 10:Volume of water collected vs Time of the day with or without the use of fins

IV Conclusion

The performance of the still with double slope is comparatively high than the single slope stills.The use of water absorbing materials like black pebbles and pin fins increases the area of absorption thereby increases the productivity of still.The heat energy from the sun maybe stored using the sand, also the use of insulation and aluminum basin in the still also enhances the performance of solar still.Maintaining the minimum water depth in the basin increases the productivity of the solar stills. The increase in the depth of water decreases the still productivity.The performance graph on different concentration of salt represents that the higher salt concentration has less productivity comparatively to the lesser salt concentration.The usage of external reflector to the double slope solar still would improve the productivity of the still.As we reduce area of collector basin enhances the productivity of still and vice versa.The orientation inclination of the glass cover improves the rate of flow at the inner surface of glass cover.

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