

STEP SOLAR STILL: DESIGN MODIFICATION IN SOLAR STILL AND INCORPORATION OF PHASE CHANGING MATERIAL TO INCREASE THE EFFICIENCY OF SOLAR STILL

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Introduction:

Water is the basic necessity for human along with food and air. There is almost no water left on Earth that is safe to drink without purification. Only 1% of Earth's water is in a fresh, liquid state, and nearly all of this is polluted by both diseases and toxic chemicals. For this reason, purification of water supplies is extremely important. Moreover, typical purification systems are easily damaged or compromised by disasters, natural or otherwise. This results in a very challenging situation for individuals trying to prepare for such situations, and keep themselves and their families safe from the myriad diseases and toxic chemicals present in untreated water. Everyone wants to find out the solution of above problem with the available sources of energy in order to achieve pure water. Fortunately there is a solution to these problems. It is a technology that is not only capable of removing a very wide variety of contaminants in just one step, but is simple, cost-effective, and environmentally friendly.

In this project an attempt is made to extract the fresh water from saline/brackish water by designing and fabricating an equipment called Step Solar Still. This Step Solar Still uses sunlight to condensate water on glass which is placed on top of the Step Solar Still and also it is composed of Phase Changing material (Bitumen) beneath the water tray which helps in extracting fresh water after sunset by its latent heat property.

Objectives:

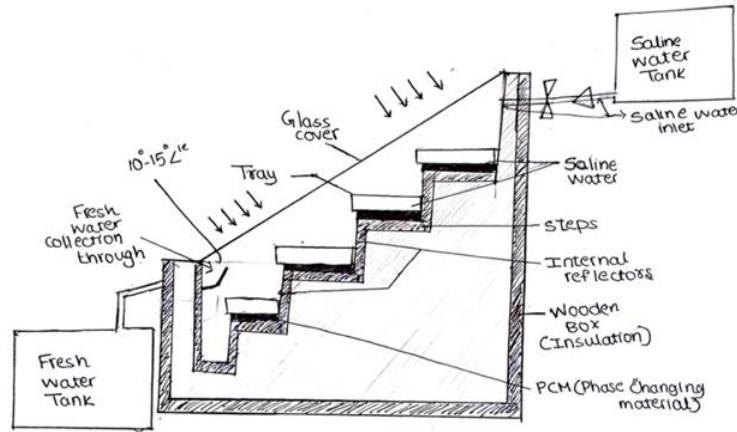
1. To design and fabricate step solar still.

This equipment is designed and fabricated to extract the fresh water from saline water and it will be more efficient compared to normal solar still

2. To increase the efficiency by using Phase Changing Material (BITUMEN)

This phase changing material plays a very important role in increasing the efficiency of Step Solar Still because of its phase changing property. Phase changing property is nothing but changing its phase from solid to liquid and liquid to solid. While changing its phase from solid to liquid during day time it absorbs the heat of sunlight and the same absorbed heat is liberated back to the water containing tray by changing its phase from liquid to solid after sunset

Methodology:



Importance of Step Solar Still:

Stepped solar still: In this type, flat basin of conventional solar still is replaced with step tray basin. These steps increase surface area of water in small space to cause more evaporation and thus increase the production rate of distilled water and also a phase changing material is also used to increase the productivity in Step Solar Still Phase Changing Material: This material absorbs solar radiation in the day time and release the same heat after sunset to heat the water, which in turn evaporates water and condenses inside the glass cover

Principle Operation of Solar Still

- A solar still operates on the same principle as rainwater evaporation and condensation. The water from the oceans evaporates, only to cool, condense, and return to earth as rain.
- When the water evaporates, it removes only pure water and leaves all contaminants behind. Solar stills mimic this natural process.
- A single basin solar still has a top cover made of glass, with an interior surface made of a waterproof membrane. This interior surface uses a blackened material to improve absorption of the sun's rays.
- Water to be cleaned is poured into the still to partially fill the basin. The glass cover allows the solar radiation (short-wave) to pass into the still, which is mostly absorbed by the blackened base.
- The water begins to heat up and the moisture content of the air trapped between the water surface and the glass cover increases
- The base also radiates energy in the infra-red region (long-wave) which is reflected back into the still by the glass cover, trapping the solar energy inside the still (the "greenhouse" effect).
- The heated water vapor evaporates from the basin and condenses on the inside of the glass cover. In this process, the salts and microbes that were in the original water are left behind.
- Condensed water trickles down the inclined glass cover to an interior collection trough and out to a storage bottle.
- The still is filled each morning or evening, and the total water production for the day is collected at that time. The still will continue to produce distillate after sundown until the water temperature cools down.
- Feed water should be added each day that roughly exceeds the distillate production to provide proper flushing of the basin water and to clean out excess salts left behind during the evaporation process.

Component description:

Basin :2*2 feets, Black Liner, Transparent Cover :2*1.5feets, Condensate Channel, Sealant, Insulation, Supply and Delivery System

Result:

Table 1. Saline water input=2 liters 2000ml without Phase changing material

Time in Hrs	Temperature (14 Jun 2022)	Output in ml (without PCM)
9:00	27	0
10:00	31	0
11:00	31	10
12:00	31	30
13:00	31	70
14:00	30	110
15:00	28	90
16:00	25	60

Total 370mL of fresh water output obtained from 2000mL for without phase changing material

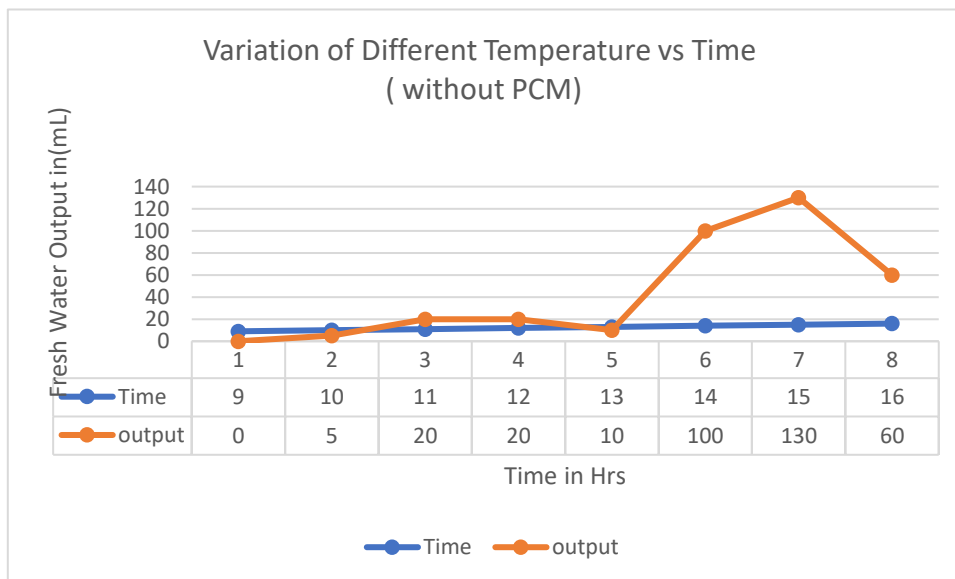
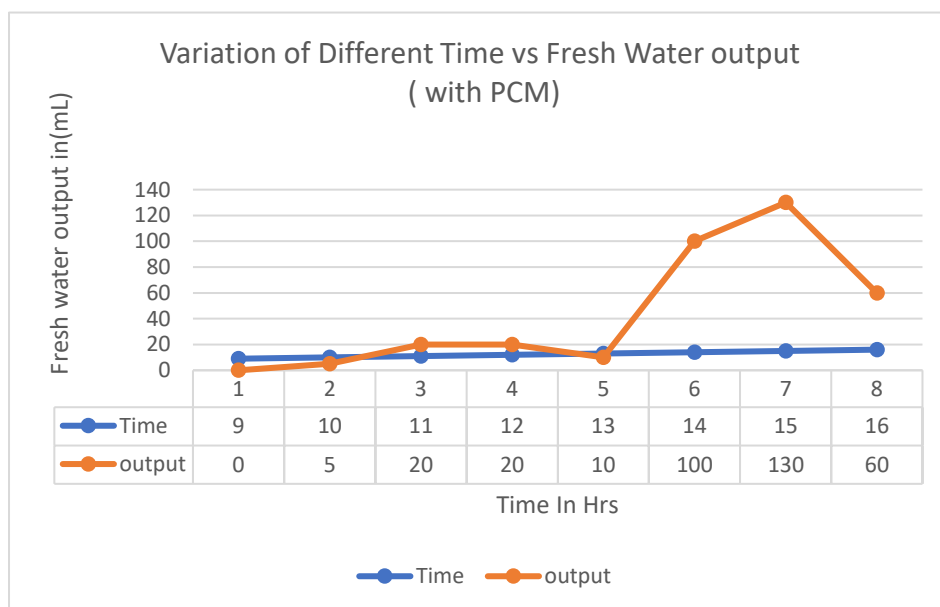


Table 2. Saline water input=2 liters (2000ml) with Phase changing material

Time in hrs	Temperature (15 Jun 2022)	Output in ml (with PCM)
9:00	28	0
10:00	30	5
11:00	32	20
12:00	30	20
13:00	29	10
14:00	29	100
15:00	27	130
16:00	26	60
17:00	20	70

Total 415mL of fresh water output obtained from 2000mL for with phase changing material



Conclusion:

By looking at the objective of this project it can be concluded that the design and fabrication is suitable to get the results and the results obtained for both the cases are satisfactory. As it is observed from the result, the output obtained for Step Solar still with phase changing material is increasing as compared to Step Solar Still without phase changing material. The impression is fresh water can be extracted after sunset is possible from this equipment and also output can be increased by incorporating phase changing material

Outputs:

- Without PCM
Saline water input=2 liters 2000ml
Total 370mL of fresh water output obtained from 2000mL
- With PCM
Saline water input=2 liters 2000ml
Total 415mL of fresh water output obtained from 2000mL

Future Scope

This same project can be further proceeded to get the output in different manner by using some other phase changing material like Wax, Wick and fat of animals. And also the thickness of the water level can be varied and the same results can be compared. From the point of design double slope Step Solar Still will be more efficient as compared to single slope Step Solar Still.