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An Experimental Analysis of Effective Double Slope Double Basin Solar Still Using Evacuated Tubes & Reflectors

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ABSTRACT: In our project, we are using Double Basin Double slope Solar still. So that we are going to fabricate the frame work by means of wood for both lower basin and upper basin is of size 900mm×900mm×300mm and 900mm×600mm×300mm are used. Here the saline water is preheated by passing the saline water into the evacuated tube and at the other end the hot saline water can be collected. Already be know that wood is good insulator and the heat transfer rate of wood is also too low. Thermal conductivity of wood is 0.04 to 0.12 W/m K. Slope work is carried out by glass sheets in which the upper slope glass having thickness of 5mm and lower slope glass with thickness of 3mm. Reflectors are placed on the top edges of the solar still. Inner surface of the lower basin is made up of mild steel sheet metal coated with FRP black paint. Upper basin is fully made up of glass as a stepped basin because of penetration of solar energy to the lower basin. Near the edges of the glass slope, there is a collector placed in all the edges of the slopes in which the pure fresh water is collected and transferred to the vessel through tubes.

KEYWORDS: Evacuated tubes, Thermocouple, Stepped glass basin, Solar desalination.

I. INTRODUCTION

People can remain a live for a several days without food, but cannot live for more than a week without water. We have all heard it said that we should drink a minimum of 8 glasses of water each day. However, drinking the minimum will only help maintain a minimum level of health. Our body will use at least 8 glasses of water each day under normal, relatively passive activity to maintain basic bodily functions like digestion, temperature control, joint lubrication, and skin hydration. Each time we exhale, blink our eyes, or make any kind of movement at all, we use up some of the available water in our system. This natural process is copied on a small scale in basin type solar stills. [Bendfeld, J., Broker and Carvallo, P.C.M., 1998].

Today fresh water demand is increasing continuously because of the industrial development, intensified agriculture, improvement in standard of life and increase in the world population. Only 3% of total water is potable but this amount is also evenly not distributed over the earth. Lack of fresh water is a prime factor in inhibiting regional/economical development. Often water sources are brackish/containing harmful bacteria, therefore cannot be used directly for drinking purpose. The oceans constitute an inexhaustible source of water but are unfit for human consumption due to their salt content in the range of 3% to 5%. In addition, there are many coastal locations where seawater is abundant but potable water is not available.

Therefore it is an urgent need for clean and pure drinking water in many countries. In order to solve this problem, some new drinking water sources should be discovered and new water desalination techniques be developed.

In recent years desalination of water has been one of the most important technological work undertaken in many countries. The fossil fuel burning water desalination techniques are in use since long back. These systems range up to 10 ton/day capacity. The main water desalination or purification methods are distillation, reverse osmosis and electro dialysis. Cleaner energies such as natural gas, solar thermal power and photovoltaic technology must be integrated with desalination technology. For bigger systems, reverse osmosis and electro dialysis are more economical, but for smaller ones, simple solar stills could be preferred because of their low costs and less floor area.



II. RELATED WORK

On deserts and islands where underground water is not readily available and cost of water shipping is high, it is worthwhile to produce potable water from saline water using solar energy. Utilization of solar energy for water desalination is becoming more attractive as the cost of conventional fuels/energy is continuously increasing. Solar desalination is particularly important for locations where solar intensity is high and there is a scarcity of fresh water. Solar desalination is a process where solar energy is utilized to distill the fresh water from saline/brackish water for drinking purposes, in charging of the batteries, research laboratories and medical appliances etc.

The combination of solar energy with desalination processes can be classified into two main categories: 100% solar driven desalination plants or partial solar powered desalination plants. Solar plants could be designed to operate in a fully automatic fashion in the sense that when the sun rises, heat collection process is initiated automatically by a sensor measuring the solar radiation.

III. METHODOLOGY

The operating principle of a solar still used for water desalination involves phase change water vapour. It permits the separation of the water constituents into salts deposits and distilled water. In fact, the solar flow transmitted through the glass cover achieves the absorber, which in return emits thermal radiations, this fact heats water. Under the influence of heat, sea water evaporates successively leaving only water's molecules, a dissolved salt deposit and all other residues in seawater. The obtained vapour condenses and the distilled water streams on the interior face of the inclined slope glass put in drains which drives it into a stocking tank. The different heat fluxes intervening in the heat transfers which occur within the still become explicit by many physical phenomena. The various modes of transfer of the exchanged heat between the water and the glass are done by convection, by radiation and by evaporation. The still is a system which exchanges the heat with the outside through the glass by convection and bottom and side insulating walls are done by conduction and radiation. In what follows we determine the heat transfer principle inside and outside the still.

The Absorber: The water layer receives both by conduction and convection a heat flux from the absorber and transmits by conduction a flux to the insulator.

The Water: The Water yields by radiation the flux and by natural convection the flux, by evaporation during the change phase a flux, on the condensation surface (the interior glass of the still).

The Glass: From the inner side, the glass receives the flux by convection, by radiation and by evaporation. Consequently, from the inner side, the glass diffuses to the ambient air the equivalent sum of two flows.

The Insulator: The insulator receives by conduction a flux from the absorber and can yield to the outside and respectively by radiation and convection.

IV. ECONOMIC ANALYSIS

The payback period of the experimental setup depends on the fabrication cost, operating cost maintenance cost, cost of feed water. Whereas cost of feed water is negligible.

- Fabrication cost to be considered = Rs. 17000
- Operating cost = Rs. 10/day
- Cost of distilled water/lit = Rs. 20
- Productivity of the solar still = 8 Litres/day
- Cost of water produced per day = cost of water/litre × Productivity

$$= 20 \times 8$$

$$= \text{Rs. } 160$$
- Net earnings = cost of water produced – maintenance cost

$$= 160 - 5$$

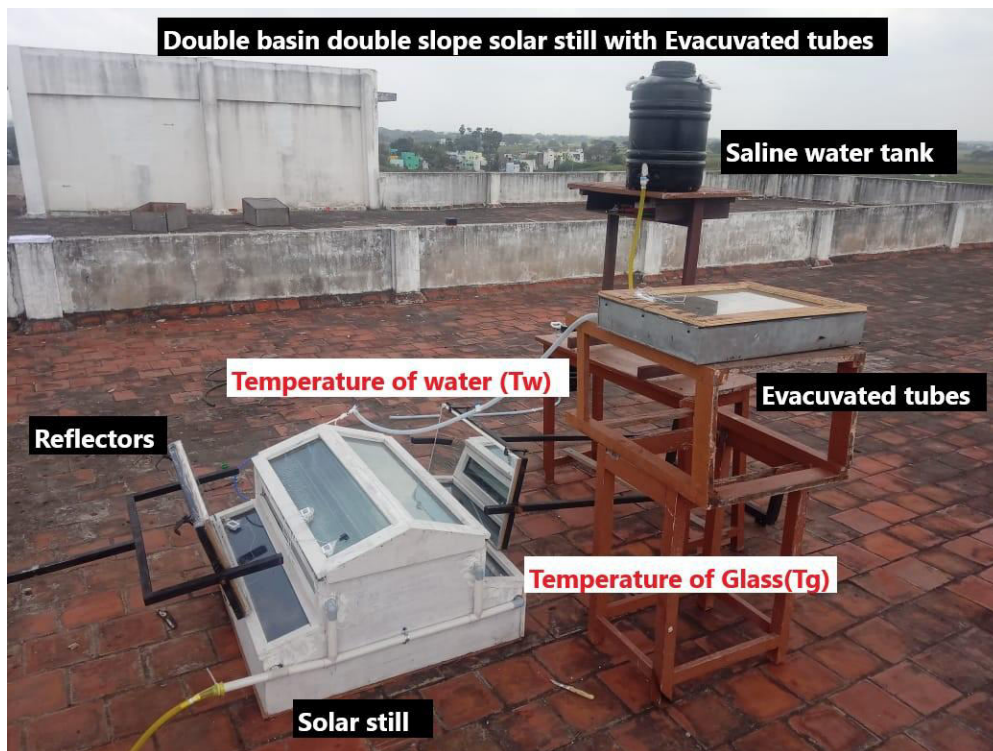
$$= \text{Rs. } 155$$
- Payback period = Investment/Net earnings

$$= 17000/155$$

$$= 110 \text{ days}$$

V. EXPERIMENTAL PLAN

Experiments are planned to conduct at the Mechanical Engineering Department block of FXEC, Tirunelveli during the months February and March. Experiments are conducted on the days which are selected in such a way that there should have clear sky conditions. The cloudy days present in these months are excluded. The experiments are conducted for different water depth at different time intervals of different days of February and March. For these experiments the condition for best performance of solar still is obtained in terms of yield. The selected days for conducting the experiments have similar pattern of global radiation.



VI. EXPERIMENTAL RESULTS

The model presented can be used to study the effect of solar radiation, ambient temperature, wind speed, glass cover temperature, transparent cover properties, etc. on the distillate output. Some of the conclusions are as follows:

- The still output (productivity) is strong function of solar radiation on a horizontal surface. The distillate output increase linearly with solar insolation for a given ambient temperature.
- The increasing of temperature difference between the saline water and the glass leads to a better production.
- Although fabrication of the double basin increased the manufacturing cost a little, high yield of the distillate made it a better one.
- The output was high at the lower water depth of 1 cm for double basin double slope solar stills.
- A maximum of 6.852 l/0.9 m² day was obtained at 1 cm water depth by the simple double basin double slope solar still. But, the double basin double slope solar still coupled with evacuated tube gave 8.165 l/0.9 m² day.
- The increasing of ambient temperature decrease the heat loss from solar still, resulting in higher distillation rate.



VII. FACTORS AFFECTING SOLAR STILL

For using solar energy to distilled brackish and sea water to produce fresh water, there are many parameters affecting the productivity. These can be summarized as:

- Solar radiation
- Ambient air temperature
- Wind velocity
- Depth of the brine in the basin
- Cover material and its shape
- Ground and surrounding losses

VIII. CONCLUSION

- Solar stills are used in cases where rain, piped, or well water is impractical, such as in remote homes or during power outages.
- In subtropical hurricane target areas that can lose power for days, solar distillation can provide an alternative source of clean water.
- Today, seawater and brackish water desalination is a subject of concern of many researchers all over the world.

IX. ADVANTAGES

A typical size solar distiller can produce 8 litres per day during the summer, dropping to 4 litres in the winter season. It should be out in the sun, it takes 10 square feet (0.9 square meters) and it weighs 30kg. The advantages are,

- Free of charge sun energy (during sunlight it eliminates 500 Watt electric consumption per one hour of sunlight)
- There are no moving parts; it is therefore reliable and almost maintenance free (cleaning is required though)
- Water taste is claimed to be better since the device act as a Solar Water Vaporizer and it doesn't boil the water (resembling rain water)
- Neutral pH is claimed (like rainwater), not like the not neutral pH of steamed distilled water
- The recourse to the desalination by distillation using solar energy represents an appreciable element of the water resource and constitutes a realizable, simple, profitable, operational solution technically

X. RECOMMENDATIONS

To increase the productivity we must increase the temperature difference between the water and glass cover. In order to obtain a higher temperature difference, we recommend:

- A preliminary heating of the brine before bringing it into the solar still.
- A cooling of the glass by using a fan working with an electrical energy which is produced by a photovoltaic system.
- A cooling of the outer side of the glass by flowing first the water through the glass, before water it into the solar still.
- And the use of glass having blades at its external side, in order to increase heat losses by convection, leading to cooling the inner side of the glass.

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