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Design and Implementation of Solar Still Distillation

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Abstract: **-** 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 solar 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. Our project goal is to efficiently produce clean drink able water from solar energy conversion. Distillation is one of many processes that can be used for water purification. This requires an energy input as heat, electricity and solar radiation can be the source of energy. When solar energy is used for this purpose, it is known as Solar Water Distillation. Solar Distillation is an attractive process to produce portable water using free of cost solar energy. This energy is used directly for evaporating water inside a device usually termed a "Solar Still". Solar stills are used in cases where rain, piped, or well water is impractical, such as in remote homes or during power outages. Different versions of a still are used to desalinate seawater, in desert survival kits and for home water Purification. For people concerned about the quality of their municipally-supplied drinking water and unhappy with other methods of additional purification available to them, solar distillation of tap water or brackish groundwater can be a pleasant, energy efficient option.

Keywords: *Solar Still Distillation, Glass, Waterproof Plywood, Pvc Pipe, Black Silicon, Different Ports, Water TDS Meter.*

I. INTRODUCTION

Water is a basic necessity of man along with food and air. Fresh water resources usually available are rivers, lakes and underground water reservoirs. About 71% of the planet is covered in water, yet of all of that 96.5% of the planet's water is found in oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps and 0.001% in the air as vapor and clouds, Only 2.5% of the Earth's water is freshwater and 98.8% of that water is in ice and groundwater. Less than 1% of all freshwater is in rivers, lakes and the atmosphere. Distillation is one of many processes available for water purification, and sunlight is one of several forms of heat energy that can be used to power that process. To dispel a common belief, it is not necessary to boil water to distill it. Simply elevating its temperature, short of boiling, will adequately increase the evaporation rate. In fact, although vigorous boiling hastens the distillation process it also can force unwanted residue into the distillate, defeating purification. Solar Distillation is by far the most reliable, least costly method of 99.9% true purification of most types of contaminated water especially in developing nations where fuel I lead acid batteries, laboratories, hospitals and in producing commercial products such as rose water. Conventional boiling distillation consumes three kilowatts of energy for every gallon of water, while solar distillation uses only the free pure power of the sun. Expensive filtration and deionizing systems are even more expensive to purchase and use and will not totally purify the water by removing all contaminants. No additional heat or electrical energy is required in our still and even after the sun sets, distillation continues at a slower pace into the night. Recently, we've been experimenting with a unique optional solar energy booster using our top quality "Sola Reflex reflector" to increase the water vaporization by increasing the temperature on the internal fluid heat absorber. This will add efficiency and increases the amount of daily pure water production.

A. Glass

Glass is a non-crystalline amorphous solid that is often transparent and has widespread practical, technological, and decorative usage in, for example, window panes, tableware, and optoelectronics. The most familiar, and historically the oldest, types of glass are "silicate glasses" based on the chemical compound silica (silicon dioxide, or quartz), the primary constituent of sand. The term *glass*, in popular usage, is often used to refer only to this type of material, which is familiar from use as window glass and in glass bottles.

B. Water TDS Meter

This device is known as TDS meter which is generally used to check impurity level in water with temperature. This indicates the total dissolved solids (TDS) of a solution i.e. the concentration of dissolved solids particles. Dissolved ionized solid such as salt and minerals increase the electrical conductivity (EC) of a solution, because it is a volume measure of ionized solid, EC can be used to estimate TDS. Dissolved organic solids such as sugar in microscopic solid particles such as colloids', do not significantly affect the conductivity of a solution and are not taken into account.

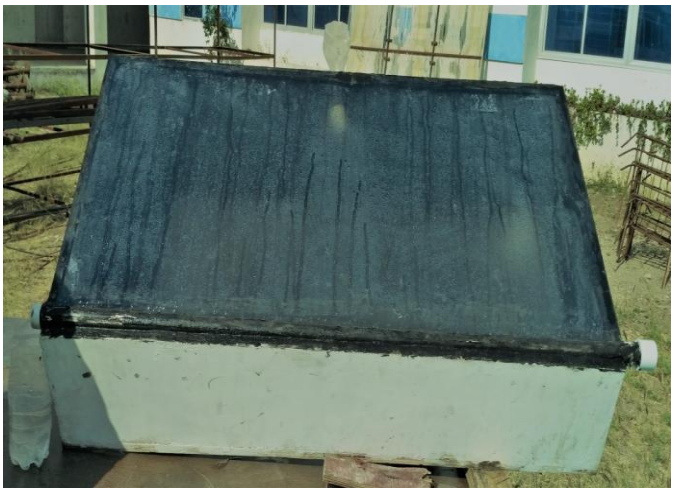


Figure1: Solar Still Distillation

II. OBJECTIVE

1) To enhance the productivity of a solar still by increasing temperature difference between water and glass, using sponge liners at the inner wall surfaces and reducing the heat losses by using energy storage materials inside the basin and by studying

the effect of various parameters like water depth, sponge liner thickness and colors, etc.

2) To develop a mathematical model to predict the performance of solar distillation system using the new calculated value of convective and evaporative heat transfer coefficients, which are obtained in thermal model.

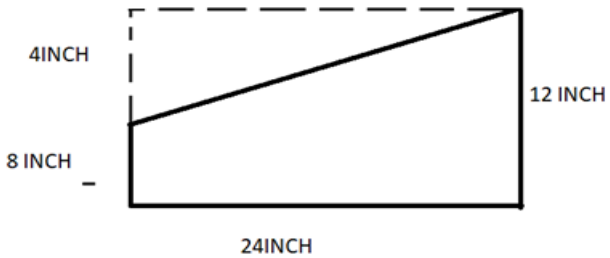
III. METHODOLOGY

Solar stills are called stills because they distill, or purify water. 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 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. There are no moving parts in Solar still and only the sun‟s energy is required for operation. 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. The most important elements of the design are the sealing of the base with black silicon.

IV. CALCULATION

Following are the dimension obtained from the solar still distillation-



$\tan\theta = P/B$

$= 4/24$

$= 1/6$

$= 1/\tan\ 1/6 \quad = 9.425$

IV. RESULT

Calculations by TDS meter- 143 PPM pure water obtained.

Duration- 5 hours.

Water obtained- 2.5 liter

CONCLUSION

The main conclusions emerging from the present work are:

- Glass cover is very important parameter for passive solar still and it is strongly depends on thickness.
- Passive solar still with 0.004 m glass cover thickness is found better compared with 0.005 and 0.006 m thickness. It increased the distillate output by 12% and 27% compared with 0.005 m and 0.006 m thick glass passive solar still.
- The integration of vacuum tubes with single basin passive solar still increased water temperature as well as distillate output.
- Single basin passive solar still possesses EPBT is 176 days and annual cost of potable water is 0.723 INR.
- Double basin passive solar still with vacuum tubes increased distillate output by 225% compared with conventional passive solar still.

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