A Review to Increase the Performance of Solar Still

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***Abstract*— Water is the basic need to sustaining life on the earth for human. With the passage of time due to technical usage and their waste disposal along with ignorance of human being caused water pollution, which led the world towards water scarcity. To resolve this problem Solar Distillation is one of the best Techniques from available another techniques. But, due to its lower productivity it cannot be commercial in the market. So that Lots of work can be done to improve the solar still efficiency or productivity. With the help of past research work we can conclude that if we are using multi-layer absorber type solar still than its productivity will going to be increased and reflective radiation losses are covered by this one.**

Keywords— solar still, passive, condensing glass cover, double slope, single slope.

I. INTRODUCTION

Water is very basic need for every human in this world. The main resources of the available fresh water are lakes, rivers reservoirs and ground water. The total 96.5% of the earth 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 even this amount is not distributed properly.

Distillation is an oldest technique to distillate brackish or saline water in to fresh water. Various technologies were invented for desalination from time to time and it has been accepted by people without knowing future environmental consequences. The various conventional distillation processes such as Multi-effect evaporation, Multi stage flash evaporation, thin film distillation, reverse osmosis and electrolysis are energy intensive techniques, and are the feasible for large stage water demands. The alternative solution of this problem is solar distillation system and a device which works on solar energy to distillate the water is called solar still. Solar still is very simple to construct, but due to its low productivity and efficiency it is not popularly used in the market. Solar still is working on solar light which is free of cost but it required more space. Its material is easily available in the market and it cannot require a higher skill for the maintenance. To increase the simple solar still efficiency so many works are done. Compared to passive solar still active solar still productivity is higher.

The solar desalination has the following benefits in comparison to other desalination processes:

i. High quality fresh water is obtained
ii. The maintenance cost is very less
iii. Any type of water can be converted into fresh water
iv. It does not required any type of moving parts
v. It does not required electricity to operate
vi. The water wastage is much lower

Over the years, substantial research has been carried out to find out ways into improving the efficiency of the process. Research work has been carried out in many parts of the world. Solar distillation uses, in common with all distillation processes, the evaporation and condensation modes, but unlike other processes energy consumption is not a recurrent cost but is incorporated in the capital cost of the solar collector. The solar still therefore, is of a simple design, construction and maintenance with ease of operation. It is best suitable for regions of the world with high solar intensities.

The mechanism of operation is based on the transmitting, absorption and reflective properties of glass and other transparent materials. The glass has the property of transmitting incident short-wave solar radiation which passes through the glass, the glass being a medium of transfer of heat, into the still to heat the brine. However, the re-radiated wavelengths from the heated water surface are infra-red and very little of it is transmitted back through the glass as it is shown in Figure 4. Today, producing volumes of pure potable water is not only technically feasible but equally economically viable using the desalination of seawater. The challenge though has been to produce potable water for rural communities for drinking and sanitation to help meet the

Millennium Development Goal without compromising standards. In meeting the challenges of the provision of potable water for drinking and sanitation, huge desalination plants have been built. The introduction of dual-power plants were also deployed to reduce the cost of electricity and water which could impact negatively on the populace. [2]

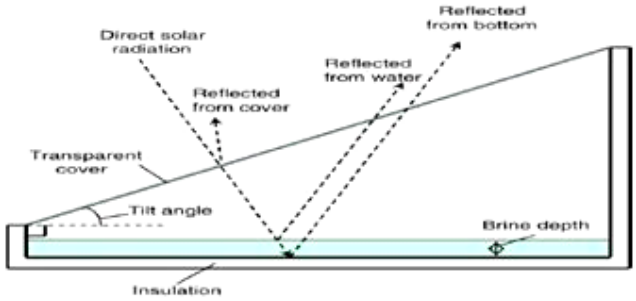

Figure 1: Schematic diagram of a basin-type solar still [1]

On a practical basis, certain things ought to be taken into consideration while designing and operating a solar still. For instance, shallow basins require large expanse of land. This land has to be cleared and leveled in readiness for the installation of the still; obviously this attracts some additional cost. Oftentimes and because the water to be treated is salt water, salt crystals build up on the dry part of the basins. This can reduce the overall absorption area of the basin, thereby impacting negatively on the effective basin area. Leakage can cause distillate to leak back into the basin or even leak out of the basin [3]. It is equally necessary to flush the still basin on a regular basis so as to remove accumulated salts and microbes that might have grown in the brines.

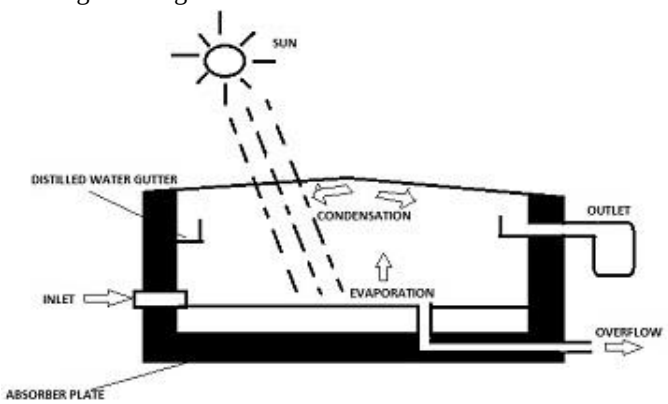

Figure 2: Basis concept of solar distillation [3]

II. SOLAR STILL

The solar still basin is filled with the salty water and sun rays are passed through the glass cover and drop on the water which is in the basin .after that water will start evaporates and steam will be generated. Due to low density it will start moving upwards after that it will stick on the glass cover of solar still.steam will leave all the contaminates and microbes in the basin.

After that this steam will start vapourised and changed into water. This purified water runs through the lower side of solar still and after that collected into the closed container .that water is fresh or potable and can used for drinking.

On the working principle the solar still are divided into two types

i. Active solar still
ii. Passive solar still

In the passive solar still the solar radiation are are directly received by the basin water so there is lower evaporation will be of water due to lower temp .so the productivity of passive solar still will be less.

There are various research work are done on solar still to increase the productivity. a passive solar still, the solar radiation is received directly by the basin water and is the only source of energy to raise the water temperature and consequently, the evaporation leading to a lower productivity. The purified water vapour will condensate on the inner side of the glass runs through the lower side of the still and then gets collected in a closed container which is used as drinkable water.

Many solar desalination systems were developed in years by using the above principle of solar still in the world. So many works done on solar still, on this work solar still is divided in two parts: (i) passive solar still, (ii) active solar still. In a passive solar still, the solar radiation is received directly by the basin water and is the only source of energy to raise the water temperature and consequently, the evaporation leading to a lower productivity. This is the main drawback of a passive solar still.

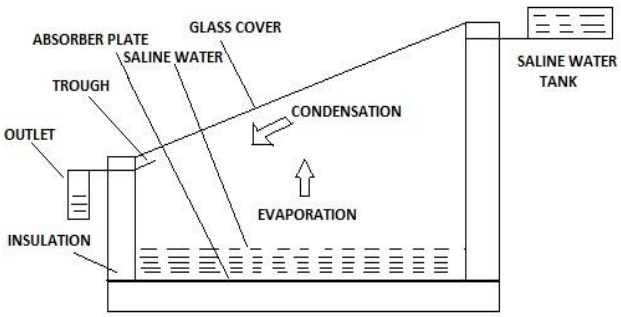

Figure 3 Simple solar still [4]

III. Improvement of Cover Plate of Solar Still

Cover plate is attached at the top of the solar still which receive the radiations of the sun and directed to basin to evaporate the water.So if we will improvement in the cover plate of solar still then the maximum radiation will be incident on it and evaporation rate will be high so the productivity will be increased.

IV. Inclination and Direction of Cover Plate of Solar Still

Inclination is an important factor in the solar still because if inclination of glass cover will be lower then the condensed water droplets will not reach to glass cover and drops into water basin. Glass cover angle effects the performance the solar still.

On the cover glass reflectance and transmittance is very important. Solar still with cover plate inclination from 10º to 50º was tested(AboulEnein et al 1998). Tiwari and Tiwari conducted indoor experiments on experimental still with various cover plate slopes and found that a higher yield was obtained with an increase in temp. For a 30º slope compared to 15º and 45º slopes of the condensing cover.

Latitude is also play an important role because helps to select the single basin and double slope solar still. In lower latitude places, double slope solar still and higher latitude places, single slope solar still is preferred. For solar still, cover inclination is also play important role because when the evaporation of water starts, water vapor is produced and due to its lower density it goes above and stick to the inner side of glass cover. So if inclination of cover is lower so water droplets will not reach to glass cover and fall inside the basin. Solar still with various angles like 10 to 50 degree have been tested. [7]. Tiwari et.al has taken experiment on solar still and found that there is a significant effect on performance of solar still. Angle of glass cover has also remarkable effect on performance. Optimum glass cover angle increase the condensation rate because slope is improved and speed of distilled water output is increased. Higher angle of slope reduces the condensation rate. [8]

V. Wind Velocity

Wind velocity also affects the productivity. At low speed wind velocity the heat losses by convection process will be low so productivity will be more. If the wind velocity is high then the heat losses will be more and productivity will be less. This causes a decrease in the condensing surface temperature and accordingly increases the yield of a still. The experiment shows that when the wind speed or velocity changes from 1 to m/s decreases by 13%. [9]

VI. Use of Sprinkler at Top of Solar Still

Sprinkler or cooling film is very important part to increase the productivity upto 30-40% because it increases the condensation of water vapour.it is located on the top of glass cover and it is perforated from the perforated tray. When the water falls on the outer side of glass cover and cools hence the temperature of water vapour decreases and starts condensed. Fig. shows that sprinkler increases the productivity upto14-15%.

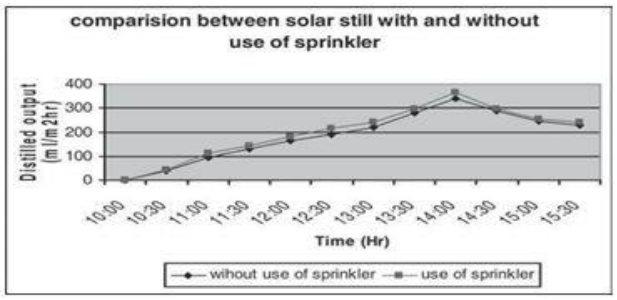

Figure 4: Use of Sprinkler in Solar Still

VII. Gap Distance between Evaporating and Condensing Cover

If we reduce the gap between the evaporating surface and the condensing cover then the performance will be increased. Reducing the gap distance will reduce the height of the walls of cover slope and hence reduce the shadowing effect of these sides. If we will put the gap distance from 8 cm. to 13 cm. for the same cover plate then the output will increase approx. 11% [10].

VIII. Improvements in Basin of Solar Still

Basin is the part of solar still on which brackish water is stored and all the radiations are incidents on it. So the basin should be made of such type of materials that it should absorb all the radiations and reflectance should be the minimum.

IX. Basin with Different Depth of Water

The experiments have been conducted on a south facing, single slope, solar still of 30° inclination of condensing cover, in summer climatic condition for 24 h on different five days for different five water depths from 0.04 m to 0.18 m. [14] It is understood that heat transfer coefficients depends on water depth. It is observed that the noctumal distillation is significant in case of higher water depth because of reduced ambient and stored energy within it.

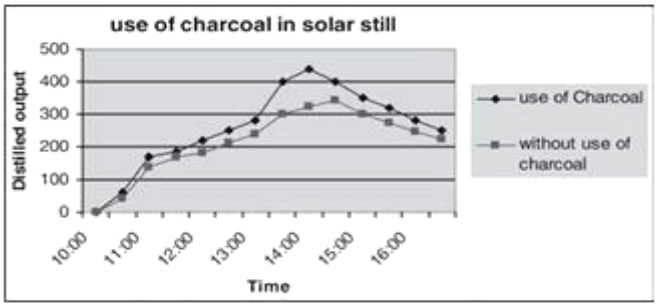

Figure 5: Conventional type solar still with GRP body [14]

X. Types of Energy Storing Materials

A black material has disadvantage of storing more amount of heat energy and increase the heat capacity of the absorption of solar radiation in basin. Glass, rubber, gravel saw dust and sponge cube are some material which are used as energy storing material. if we use black rubber that will increase the productivity up to 20%.

XI. Types of Absorbing Materials

There are various types of energy absorbing materials which are used to increase the evaporation rate of solar still. Charcoal is best material which are used for solar energy absorbing materials because charcoal is best material to increase the absorption capacity of the basin liner[13]..By using cahrcoal it increases the productivity upto 10%.

XII. Future Scope of Work on Conventional Type Solar Still

If, we create a model of solar still with two or multi layer absorber plate and give the thermal contact together, then it utilize the maximum solar energy, covers the loss of solar radiation, increase the heat transfer area in the same $1m^2$ basin, and increases the productive output of solar still.

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