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A Review Paper on Effect of Different Parameters to Optimize Yield of Solar Still

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Abstract -The worldwide demand of potable water is continuously increasing because of population and industrial growth, the result is the shortage of water in many places of the world. To overcome these problems there is a demand for some supportable sources for the purification of water, one of them is solar still. Solar still is a device used to convert brackish or saline water in to drinkable water. In this article a review of different parameters affecting the performance of solar still (like climatic conditions, design, absorber materials, Internal and external reflectors, energy storing materials) has been studied. Use of phase change materials in basin caused significant enhancement in productivity of solar still whereas use of external condenser coupled with single basin solar still increased the productivity. Considering some design parameter while design and development of solar still affects very much distillate of solar still.

Key Words: Solar Still, Desalination, Purification of brackish water, distiller.

Abbreviations:

TDS- Total dissolved solid
PCM- Phase change material

1.INTRODUCTION

The provision of fresh water is becoming an increasingly important issue in many areas of the world. Among the non-conventional methods to desalinate brackish water or seawater, is solar distillation. The solar still also known as distiller is the most economical way to accomplish this objective. Solar distillation may be one of the viable options for providing drinking water for a single house or a small community in an arid or coastal region. A solar still can be easily built on-site without using special tools. This easy assembly helps to shorten the transportation distance of the water from the still to the point of use.

In conventional basin type solar still, the still consists of a shallow airtight basin lined with a black, impervious material, which contains Brackish or saline water. Solar radiation received at the surface is absorbed effectively by the black surface and heat is transferred to the water in the basin. Temperature of the water increases and it increases the rate of evaporation. A sloping transparent cover is provided at the top. Water vapour produced by evaporation rises upward and condenses on the inner surface of the glass cover which is relatively cold. Condensed water vapor trickles down into the trough and from there it is collected in the storage container as distilled water.

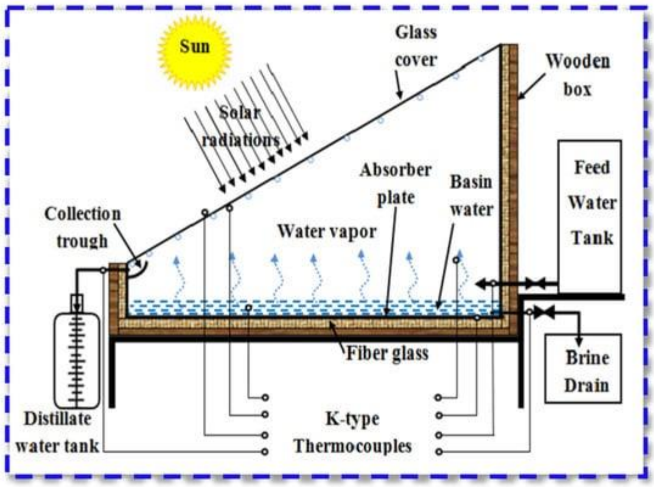

Fig.1 Schematic diagram of solar still [1]

2. CLIMATE PARAMETER TO OPTIMIZE PRODUCTIVITY OF SOLAR STILL.

2.1 Effect of solar radiation and ambient temperature:

Increasing the solar radiation incident on the distillers results in an absolute increase in the freshwater productivity and thermal efficiency of the solar stills. This is simply due to the increased input energy to the solar still. Moreover, the dusty and cloudy weather affect badly the performance of the distillers as a result of diffusing the incident sun rays on the glazing cover. The authors found that a slight increase in the distiller yield (around 3%) could occur when raising the air temperature by 5 °C[1]

2.2 Effect of Wind Speed on Water Production:

At the minimum cumulative water productivity of 1675 mL/day, average wind speed was obtained as 1.93 m/s. The average wind speed of 2.04 m/s was occurred at the maximum cumulative water productivity of 2005 mL/day. it is observed that the hourly distillate output curve with the highest average wind speed remains higher than that corresponding to the lowest average wind speed. On other hand, with the increase of average wind speed from 1.93 m/s to 2.04 m/s, the yield from solar still increases by 16.46%. We concluded that the average wind speed increase in relation to the yield.[2]

2.3 Affecting of Salinity Water on Productivity:

The effect of salinity on the solar still productivity is studied with brackish water and seawater which have a TDS value of 3670 mg/l and 31,000 mg/l, respectively, having 6 L of water in basin. It can be observed from Fig.2 that the cumulative productivity obtained is 2125 ml and 2005 ml for basin water TDS value of 3670 mg/l and 31,000 mg/l. We notice with the increase TDS value from 3670 mg/l to 31,000 mg/l, water cumulative production from solar still reduces 5.65%. The results revealed that the cumulative productivity decreases when there is an increase of salinity.[2]

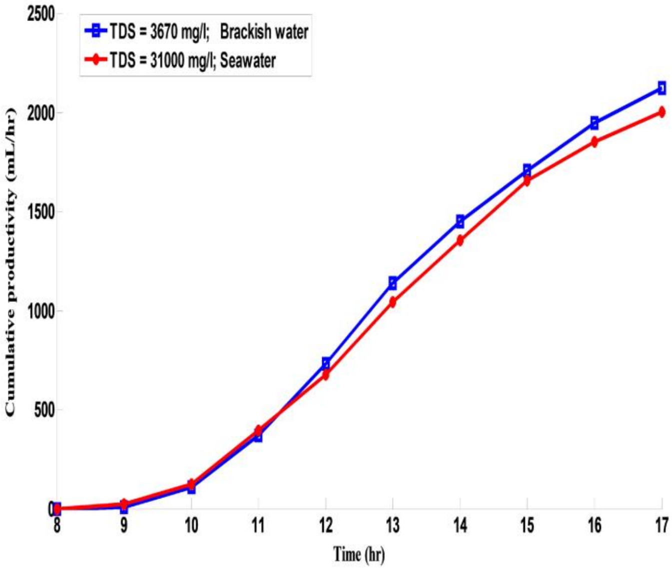

Fig.2 Variation of cumulative productivity each hour with different TDS of water used [2]

3. DESIGN PARAMETER TO OPTIMIZE PRODUCTIVITY OF SOLAR STILL.

3.1 Effect of glass covers thickness:

Lower glass cover thickness increases distillate output from solar still, i.e. 4 mm glass cover thickness produces more distillate output compared with 8 mm as well as 12 mm. Highest Distillate output is obtained in the month of November, 2010 among other 5 months (September, October, December, January, and February).[7]

3.2 Effect of material of solar still:

The daily productivity of single basin single slope acrylic solar still is 660ML/0.25M2/day and galvanized iron solar still is 585 ML/ 0.25M2/day. Compared to galvanized iron solar still acrylic solar still gives 11.36% higher productivity, the reason is acrylic solar still has low thermal conductivity compare to galvanized iron solar still.[9]

3.3 Variations in glass tilt angle:

For solar stills with the glass cover angles 20º, 31º, 45º and 50º under August weather conditions, the yield amount of fresh water increases as the cover inclination angle decreases.[17]

If the inclination angle used was lower than a certain degree, it could also be possible that the still would produce fewer distillate because the distillate would fall to the still before it reaches the effluent channel.

3.4 Direction and thickness of body:

The direction to which slope is given is also very important , in summer it is better to still face due south to attain maximum solar radiation at the end of the day , for mainly single slope solar still, for double slope solar still it is taken as east to west. The thickness of the body of the solar still was kept small at 5 mm to ensure minimum heat loss from the bottom as well as from the sides of the still.[35]

3.5 Effect of Sun tracking System:

By using sun tracker, the water temperature increases, and the thermal capacity of the water decreases, by which the evaporation rate increases, hence the production will be increased. Introducing the sun tracking system to a fixed solar still has improved the performance of the traditional fixed single slope solar system by 22%.[10]

3.6 Solar Still Integrated with Reflectors and External Condenser:

Water productivity of the stepped still increases by about 165% over the conventional still when both reflectors and an external condenser are used.[12]

3.7 Effect of floating plate:

Suspended aluminum plate is a good material to enhance the distillate output of solar still. It is cheap and easily available.[16]

3.8 Effect of incomplete sealing:

It could be noted that one of the major reasons for efficiency loss in solar stills is incomplete sealing. Hence, proper sealing, which will not be costly and difficult, must be one of the major concerns of solar still designers.[15]

3.9 Effect of Solar Pond:

The addition of solar pond to the conventional solar still increase productivity. Further increase of efficiency of the still was obtained when modifications were done to both the pond and still with fins, glass wool and reflecting mirror.[14]

3.10 Effect of stepped solar still:

The conventional solar still and stepped solar still experimental results are shows the distillation rate is higher in stepped solar still as compare to the conventional solar still.[13]

4. OPERATIONAL PARAMETER TO OPTIMIZE PRODUCTIVITY OF SOLAR STILL.

4.1 Effect of Nano fluids:

The efficiency is higher for solar still made up of copper and it can be increased further by mixing nano fluids with water inside the still. Addition of nano fluids in the basin surface increases the water temperature by increasing heat transfer rate and thereby increasing the evaporation rate. The modified innovative still working under low pressure has enhanced performance in comparing with the still working at atmospheric pressure and more flexible with climatic conditions.[4]

4.2 Effect of Water Depth and geometrical condition:

The maximum efficiency achieved with the built distiller was 46.9% when the water level within the collector – evaporator is 0.5 cm; this value decreases exponentially to a value of 8.7% when the water level is 6 cm.[6]

The possibility of increasing the water productivity could be reached by lowering the water depths on the basin- absorbing plate. It is necessary to investigate the effect of all the operational parameters before taking the decision of installing the solar distillation plant. It was found that the geographical location may having a significant positive effect on the increased water productivity, especially for those locations with an abundant solar irradiation and situated at higher elevations above the sea level, where the reduced boiling point of water and the corresponded saturation pressure are below the standard atmosphere.[6]

4.3 Effect of fins, sand, sponge and pebble:

The productivity of the single basin solar still is augmented by integrating fins at the basin plate. Effluent is used as a feed. To enhance the productivity of solar still, it is modified with fin, black rubber, sand, pebble, and sponges [8]

4.4 Phase Change Material:

The Solar still equipped with phase change material (PCM) is to be design and fabricated to improve the daily yield and efficiency of the still.[31]

The solar still becomes more effective when PCM is added with aluminum oxide (Al2O3) as the thermal conductivity of the paraffin wax gets increased when nano-particle added in that. The energy absorbing rate during day time gets increased. Thermal energy storage rate gets increased in the nano composite PCM. This was concluded as the yield of still is higher than the still with PCM.[11]

3. CONCLUSIONS

In this review, different parameters affecting to solar still is optimized for better productivity. To successfully design and develop, one needs have an in-depth understanding of affecting parameter to solar still.

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