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Performance Assessment of a Pyramid Shaped Double Slope Solar Still for Enhanced Distillate Output

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Abstract

Water scarcity is among the major problems faced by many countries across the world. With increase in population and industrialization, the degradation of common water resources is increasing. Water is one of the essential components for bolster human life. Many parts of the world have low access to potable water. Consumption of untreated impure water leads to many fatal diseases. Solar still is a clean and economical device for converting brackish and impure water to potable form. It utilizes the inexhaustible solar energy as the primary energy source. It consists of a basin which holds the impure water and a glass cover at the top through which solar radiation is incurred. In a solar still, heat relocation takes place both internally and externally through conduction, convection and radiation. The heat loss from the side walls of the solar still plays a significant role in the productivity of the solar still. A double cover pyramid solar still is fabricated and tested. It is generally detected that the yield of the solar still increases by 77% with the proposed model.

Keywords: *Active still, Double basin, Duplex still,Solar still*

I. INTRODUCTION

Adequate supply of fresh water is the uttermost essential stuff for maintaining human life. Clean water ensures socio-economic development of a country. Consuming unsafe water leads to many diseases. Freshwater sources throughout the world are exploited by the increase in population. The discharge of toxic pollutants and effluents from the industries also leads to major exploitation of fresh water. Water contamination is a creating mess around the world and the health hazard due to contaminated water is grievous. Water is one of the vital resources for human beings. The global reserve of fresh water is only about 0.014%. The lack of availability of fresh water is an extensive concern in major parts of the world. With enhancing world population and industrialization, the scarce reserve of fresh water is being fouled.

Many conventional methods are used for conversion of impure water to potable water. The conventional methods use non renewable energy which is limited and also becoming expensive. The conventional methods are available to supply potable water in rural and urban areas. In remote areas these techniques are not available. In this study, a new model consisting of a pyramid shaped double cover solar still is proposed and tested

II. EXPERIMENTAL SET UP

The productivity of the solar still can be increased by increasing the temperature of the water or by reducing the temperature of the condensing cover. In this view, a new model is proposed to decrease the temperature of the condensing cover by placing another pyramid shaped cover above the conventional one. The basin area of the solar still is kept as 0.49 m^2. The heights of the solar still at lower and higher sides are 0.2 m and 0.362 m respectively. The thickness of galvanized iron sheet is kept as 1.5 mm. The outer and inner surface of the solar still is painted black to have high absorptivity of solar radiation. The basin is covered with glasses of thickness 3 mm inclined at 13^o respectively to observe the maximum possible solar radiation.

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A hole is provided at the ground surface of the basin to drain water and impurities for cleaning of solar still. A separate hole is also provided for replenishing raw water in the basin. Another separate hole is also drilled at back side to create partial vacuum. The output of the distilled water collector from the basin is connected to another small collecting chamber where the distilled water is stored and can be utilized without upsetting the low pressure inside the basin.

Fig 1. Modified pyramid shaped double slope solar still

Fig 2. Conventional single slope solar still

The cover glazing and the basin are made vapour tight using epoxy adhesive, as it remains air tight for long time. The opening terminals are provided with ½ inch ball valves to prevent leakage. The inclination and direction of inclination depends upon the geographic location of the still [10, 11]. Glass is the preferred material for cover, since it has good solar transmittance for various angles of incidence and long service life [12], whereas a plastic can be used for short-term use.

Experiments were conducted at the roof top. During experimentation, properly calibrated thermocouples were fixed at the inner and outer surfaces of condensing covers and inside the water to measure the condensing cover and water temperature. The condensing covers are cleaned properly before the start of experiment. Experiments were conducted at the water depth of 0.03 m. The distillate output was measured for each hour by a measuring jar and the total distillate output for one day was calculated. The productivity of the modified solar still is compared with the traditional solar still of same base area as shown in Fig 2.

III. Results and Discussion

A. Productivity

The daily production yield of the conventional solar still with single slope and single basin solar still is compared with the modified solar still. It can be observed from Fig 3. that the productivity of the solar still increases by 77 % correlated to the conventional still. The main reason for this increase in productivity is due to the decrease in the temperature of the condensing cover.

B.Effect of insulation thickness

The experiments were conducted with various insulation thicknesses and without insulation.

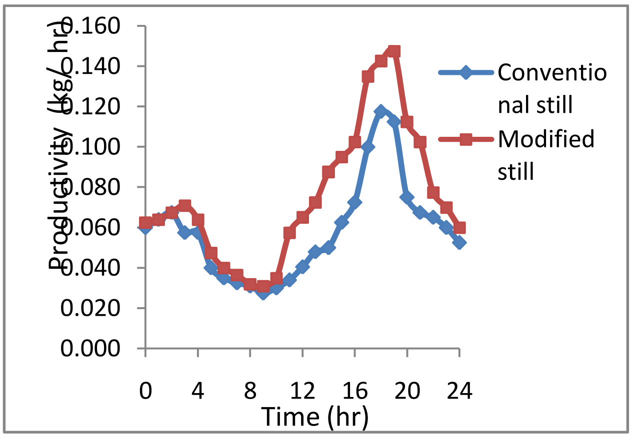

Fig.3 Comparison of the productivity of single basin and duplex solar still

Styrofoam is chosen as the insulation material as it has a low thermal conductivity of 0.037 W/m K. It can be seen that the productivity increased three times with the provision of insulation at the side walls than without insulation. The insulation thickness was varied with 0 mm, 25 mm, 50 mm, 75 mm and 100 mm. It can be inferred from Fig. 4 that the productivity increases with increasing insulation thickness However, after 50 mm insulation thickness, the effect of insulation on the productivity is low. The productivity increased to 2.124 kg/day with an insulation thickness of 50 mm compared to 1.2 kg/day without insulation. The effect of insulation is better during the off sunshine hours since the heat loss to the surrounding is minimized with insulation.

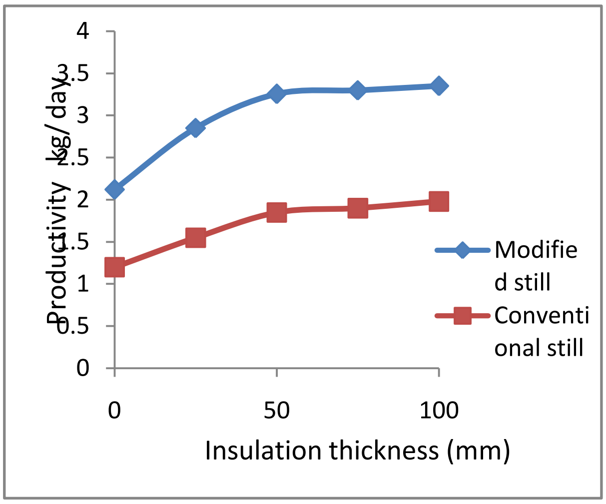

Fig 4. Effect of insulation on the productivity of the solar still

IV. CONCLUSION

The following conclusion is incurred from the experimental investigation of the modified duplex solar still, The productivity of the new model solar still is 77% higher than that of the conventional solar still as show in Fig. 3. With the decrease in the temperature of the condensing cover, the evaporation rate increases significantly thus leading to higher productivity. The productivity of the solar still increases with increase in insulation thickness. However after a certain thickness of insulation the increase in productivity is low

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