Comparative performances of single, double slope solar stills using biomass Energy and solar Energy

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Abstract- The supply of drinkable water is an important problem in the growing nations. In India the storage reservoirs are minimum Here drinking water scarcity is present in many parts of the country. One of the best and most inexpensive methods to solve those problems are by solar distillation method. In this work, a single slope and double slope stills were designed and operated along with biomass energy to increase the productivity of desalination in the still. The basin plate of both the stills were attached with a heat exchanger pipes and connected with biomass energy source. The stills were operated using solar and biomass modes. The stills were operated with 2cm minimum depth of water, energy storing, exposure materials to strengthen its production. Natural materials such as saw dust, coconut husk and palm wastes were burned in as biomass fuels. The productivity of single basin still was higher than double slope solar still. The productivity of still in biomass modes were found to be higher than solar mode. Addition of energy storage, exposure materials helps to increase the productivity to some extent.

Keywords – Biomass source, biomass fuels, energy storing materials, exposure materials, single slope, double slope still, heat exchanger

I. INTRODUCTION

Solar Desalination using a solar still is the best source in the semi arid regions to purify contaminated water. Though the output of the still is low when compared to other process, it is used because it is cost effective and no need of any external source. Tarawneh [1] has studied about the effect of water depth in the basin on the water productivity. The performance characteristics showed that the water productivity is nearly linked to the incident solar radiation intensity Badran [2] has studied the functioning of a single slope, solar still using different operational parameters experimentally. The survey also indicated that the daily production of still can be increased by shortening the depth of the water in the watershed. A multi basin solar still was developed by Senthil Rajan et al. [3] enhance the productivity to further increase the performance of the still sensible heat materials like sand, cement block, glass and latent heat storage materials such as wax were added. A 73% increase in productivity was obtained by using sensible heat storage material when compared to the conventional solar still. Murugavel et al. [4] worked on a still which contains double slope, single basin. They maintained a thin layer of water in the basin by placing many types of wick materials. They found that the production rate is a complex function of water, glass and the difference between water and glass temperatures. Benon Bena & Fuller [5] coupled a natural convection solar dryer with a biomass back up heater the analysis showed that that biomass backup drier was four times better than the solar dryer.

II. EXPERIMENTAL SETUP

The conventional solar still is constructed using galvanized steel of 1.5 mm thickness in which the base of the solar still is made of a steel box of 800mm length and 900mm breadth. The same basin were used in double slope still with condensing cover 4mm thick placed at angle of 30^0 . height of the glass is 700mm and the breadth is 600mm. The solar still is completely sealed with silicon to prevent the leakage of vapor thermocouples were inserted at appropriate places to measure water temperature and glass temperatures When solar radiation , biomass heat were supplied to the still the temperature of the water inside the still increases and condensation process takes place. The water vapor gets condensed on the glass cover. A stopper is provided at the bottom of the glass to collect the condensed water in the collection tank. Water collection troughs were providing to collect the pure water. The bottom and side surfaces were properly insulated with a thermocol layer of 4mm thick to arrest heat losses. The dimensions of the biomass boiler are 138 mm outer diameter and 520 mm height. The lower portion of the boiler

acts as furnace. The biomass material like coconut husk, palm wastes were burnt in the furnace. The ashes are removed periodically. The chimney was set up at the side to discharge the flue gases to the atmosphere.

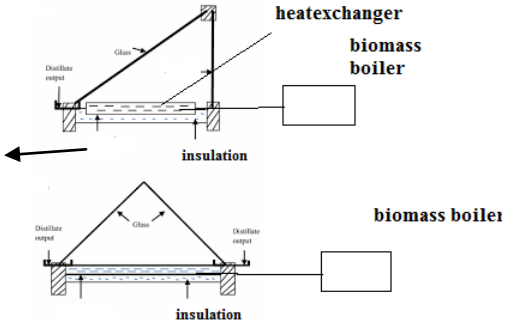

Fig.1 Experimental setup

III. WORKING

Biomass heater was supplied with 20Kg of biomass in the furnace area the burnt gases were passed through the central area of the heater. The outer surfaces of boiler were supplied with saline water heat transfer takes place between the saline water and flue gases the water was circulated inside the still by a circulation pump and heat exchanger attached at the base of the basin. The heated water from boiler enters through the heat exchanger and transfer the heat to the water inside the basin thus the water is converted to vapors these vapors reaches the top surface of glass cover and condensed by cooling air around the still. The water condensed was the distilled water it was collected in a collection trough and measured for every hour.

IV. UNCERTAINTY ANALYSIS

The measurements were taken by using standard equipments with least possible errors.
The digital temperature indicator (2%), Kipp–Zonan solarimeter (3%), vane type digital anemometers (7%), and beaker (1%) were used to measure temperature, solar intensity and wind velocity

V. RESULTS AND DISCUSSIONS

5.1 Effect of boundary thickness

The boundary layer is one of the parameter that affects the productivity in the still. The minimum boundary thickness absorbs more amount of energy from the basin as a result more amount of water gets evaporated from the still. The Fig.2 shows the effect of boundary layer. The single, double basin stills were operated in solar and biomass modes with 2cm boundary layers solar mode and biomass produces 1090Kg/m2 and1540Kg/m2 for double slope still and single slope produces 2080 Kg/m2, 1850 Kg/m2. The productivity in single slope still was found maximum.

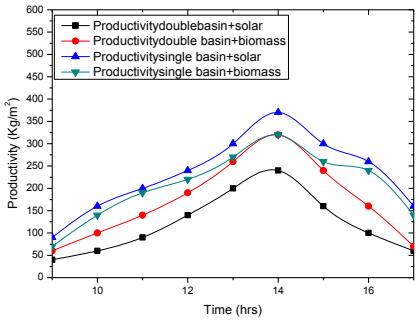

Fig.2 Effect of boundary layer

5.2 Effect of heat exchanger in the still

The stills were operated in solar as well as in biomass modes In the biomass mode the still was connected to the biomass heat source and circulating pump through the heat exchanger. The heat exchanger transfers the heat to the saline water in the still. The output showed that single slope still with heat exchanger (2170Kg/m2) performed well than with double slope (1200Kg/m2) and (1090 Kg/m2) this was shown in Fig.3

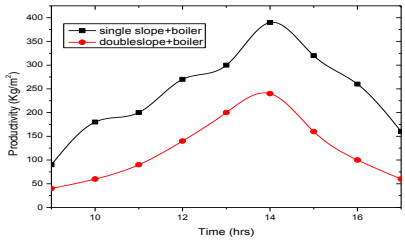

Fig.3 Effect of heat exchanger in the still

5.3 Effect of energy storing and exposure materials

The materials which stores energy and releases slowly are called energy storing materials. The energy storage occurs without any phase change they are called sensible and when phase change occurs they were called latent heat. Some materials increase the evaporation by increasing the area of exposure they are called exposure materials. In this experiment concrete wastes were used as sensible, iodine packed in billets acts as latent heat material. The cotton cloth acts as exposure materials. The sensible materials boost the productivity in pentagon still by 39% than conventional still. The addition of latent heat materials increases 34% and exposure surfaces by 22% than conventional still. This was shown in Fig.4

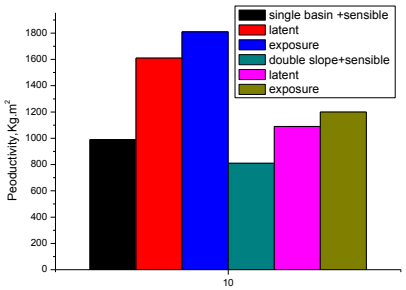

Fig.4 Effect of sensible, latent heat, exposure materials in the still

VI. CONCLUSION

The single and double basin still were constructed and attached with biomass heat source. The stills ware operated both in solar and biomass modes and compared .The study shows that

The stills were operated in solar and biomass modes with water depth of 2cm. The output from the 2cm thickness was 25% higher than double slope stills..

The sensible materials boost the productivity in single slope still by 39% than double slope still. The addition of latent heat materials increases 24% and exposure surfaces by 22% than double slop still.

Biomass mode produces higher productivity than in solar mode

The productivity was low in double slope stills because of loss of heat and area of water.

Effect of heat exchanger helps to increase vaporization rate in both the stills

Biomass used are eco friendly.

VII. REFERENCES

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