STUDIES ON THE THERMAL PERFORMANCE OF A SOLAR WATER HEATER & BIOMASS WATER HEATER

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***Abstract*: In the present work, an attempt has been made to investigate the thermal performance of a flat plate solar water heater and biomass water heaters. Experimental observations were made in Indian (20º N, 81º E) climatic conditions. Maximum 9 % variation is found between the theoretical and experimental values of outlet air temperature of the solar water heater. Maximum instantaneous collector efficiency of 42% is obtained in the present study. The biomass heater gives the efficiency of 58%.The biomass heater gives better performance when compared to solar mode.**

***Index Terms*: Solar collectors, Heatenergy, Thermal efficiency, Biomass heater, biomass**

1. Introduction

The growth of population and human, agricultural and industrial activities increases the need of pure water. 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. Huge amount of water is required for different industrial processes, only a fraction of the same is incorporated in their products and lost by evaporation the rest finds its way into the watercourses as waste water and contributed to natural bodies of water. Industrial waste either join the stream or other natural water directly Many attentions are given in India on treatment of waste water. Many attempts have been made to improve the efficiency of the stills. Ashokkumar and Tiwari [1] investigated the use of hot water in double slope heat exchanger and found that the use of hot water increases production during off sunshine hours. Voropolulos et.al [2] experimentally investigated the hybrid still coupled with solar collectors the results showed that the productivity is doubled by coupling. Badran and Tahaneih [3] found that the output of still was increased by 36% by using a flat plate collector. Velmurugan and Srithar [4] fabricated the solar still with pretreatment arrangement. This arrangement reduces the color and purity of effluent. The addition of sensible material increases the production. Senthilirajan et.al,[5] analyses Multibasin still with biomass heat sources and done analytical validation using response surface methodology. Senthilrajan et.al [6] integrated a pyramid still with single basin still using common biomass heat source with various sensible materials the results shows that the productivity of combined still was maximum in biomass mode than conventional and solar modes. . Zeinah et al. [7] used the oil heat exchanger to preheat the saline water inside the solar still and got 18% increase in productivity. In this work the performance of the single basin solar water heater is compred with biomass heater. The lower portion of the basin fitted with a heat exchanger and coupled with a biomass heater. The biomass heater acts as a heat source to supply continuous heat into the basin. The performances of still with biomass heater are compared with the performances of conventional flatplate collector.

2. EXPERIMENTAL SETUP

A solar water heater is fabricated, with galvanized iron absorber plate of size (1m x 0.95m), The thickness of the cover plate is 0.005m. A flat plate single pass solar water heater was constructed to obtain the thermal efficiencies. Here water is used as a working fluid; the observer plate is painted black in order to absorb the maximum insolation. Insulation is provided at the base of the absorber plate which minimizes the heat loss through base of the system. The other two sides of the solar water heater are also insulated to prevent heat losses from the side walls. A desired flow rate is maintained through regulator, the temperature at the different point of the system is measured with the help of k-type thermocouple. Solar intensity and wind velocity are measured with solarimeter and anemometer respectively. The biomass heater having 133mm outer diameter and shell thickness12mm and height 550mm made of cast iron was used as a high temperature source. The heater is fired tube type internally fired with locally available biomass materials. The lower part of the boiler is called the furnace where biomass is fed into the furnace through the fuel input door. The burnt ashes are gathered at the lower end and removed periodically. The lower end of fire tube is joined to the furnace and the upper end is fitted to the chimney. Boiler drum has inlet and outlet to hold the feed water from the kettle. The feed water is furnished to the boiler drum by gravity from the input feed water supply tank which is located above the elevation of the boiler. Safety valves and pressure gauges are fitted to a higher place the boiler drum for safety aspects the exhaust gases after passing through the fire tubes are exhausted to the atmosphere through chimney provided at the upper side of the kettle. The boiler is supplied with biomass and fired manually. The inlet end of the heat exchanger is connected to the boiler vent pipe and outlet end was connected to the circulation pump to circulate water again to the boiler drum. Experiments were conducted at University College, Ramanathapuram, Tamil Nadu, and India during the months of June- July 2021. The interpretations were read from morning 9am to 5pm and 6pm to 12hrs for every one hour interval for solar and biomass modes. The fig.1 shows the experimental setup.

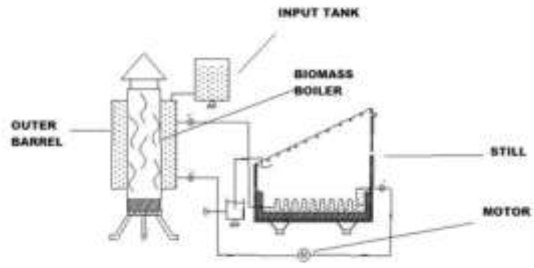


Fig.1 Experimental setup

3. Theoretical analysis

The energy balance for basin, glass, water are given below

Glass cover

$Q_w = Q_S$

$h_1(Tw-Tg) = h_2 (Tg-Ta)$

$Qw = Qew + Qrw + Qcw = h_1 (Tw-Tg)$

$h_1 = hew + hcw + hrw$

$h_{cw} = 0.822 [(Tw-Tg) + (Pw-Pg)*Tw/(268900 - Pw)]^{0.33}$

$h_{ew} = 16.273x10^{-3} \times hcw \times (Pw- Pg/Tw-Tg)$

$h_{rw} = \varepsilon\sigma [(Tw+273)^2 + (Tg+273)^2] \times [Tw+Tg+546]]$

$\epsilon eq = (1 / \epsilon g + 1/ \epsilon g - 1)^{-1}$

$h_2 = 5.8 + 3v$

Basin liner

$\alpha_b I(t) A_b = h_3 (Tb - Tw) A_b + h_b (Tb- Tg) A_b$

Water mass

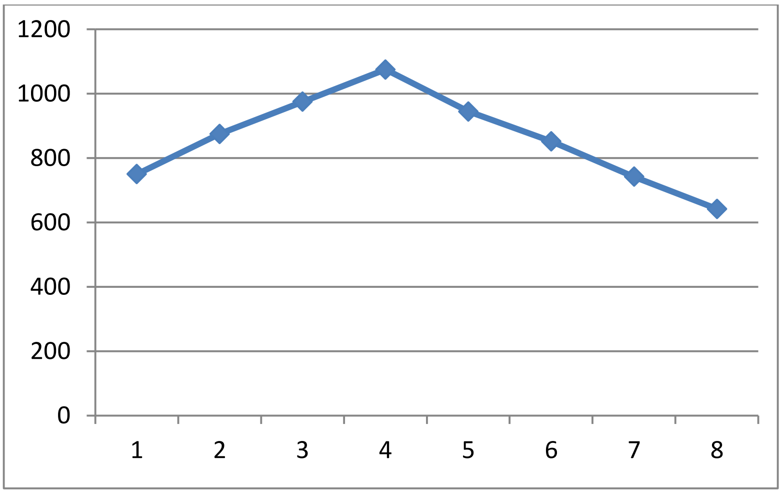
$Qhe + h_3 (Tb - Tw) A_b = M_w (dTw/dTg) + h_1 (Tw-Tg)A_b$

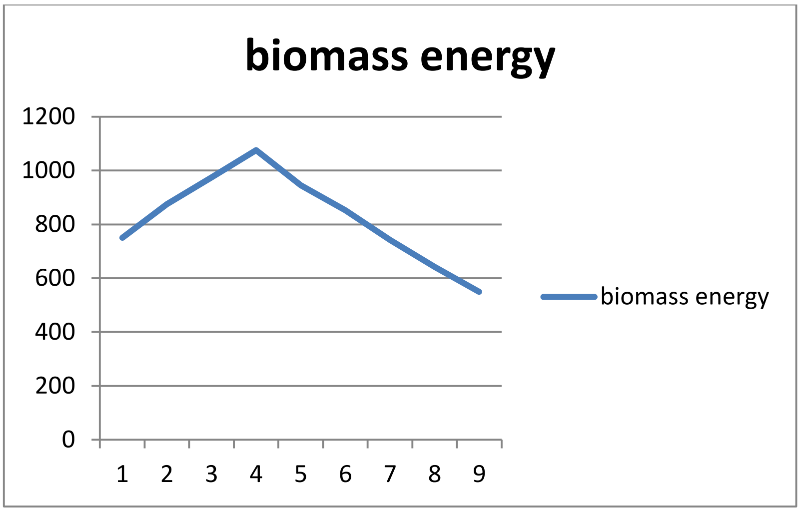
$Qhe = m \times cpw \times (Tin - Tout)$

4. RESULTS AND DISCUSSION

i. Effect of solar radiation and bio energy

The still with flate plate collector was tested in solar mode, in this mode the solar radiation gragualiiy increases with time from 645 to the peak of 975 at noon afterwards it falls. This shows that the solarradiation depends on the climate. In biomass boiler the amount of bio energy supplied vary from 792 to 1030 at noon after wards it decreases. The amount of enegy supplied depends on supply of biofuel not upon climate. Fig.2 explains the above details.





. Fig.2 Variation of Solar radiation and biomass with time

ii.Effect of water temperature on solar and biomass mode

The Fig.3 shows the effect of water temperature with time the water temperature in solar mode may vary from 12 to 38^{0}C where as in biomass mode it vary from 20 to 58^{0}C.This due to continuous supply of heat in biomass heater.

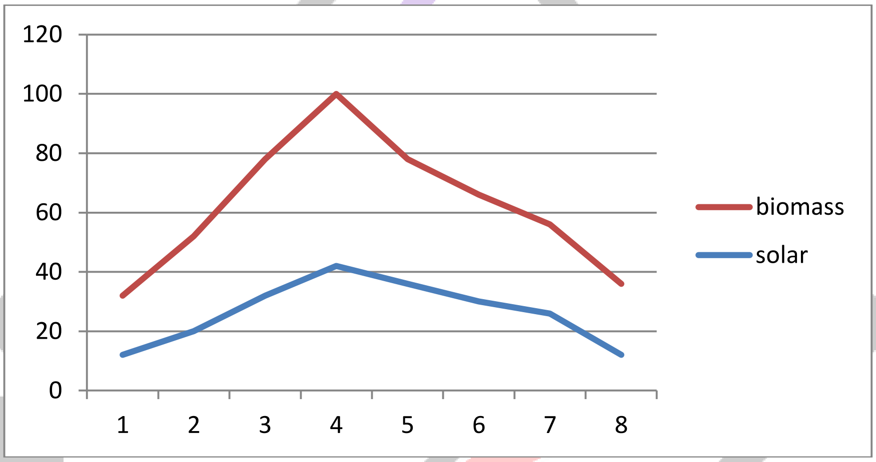


Fig.3 Effect of water temperature with time

iii. Effect of efficiency on solar and biomass mode

The Fig.4 shows the effect of efficiency in solar mode may vary from 12 to 42% where as in biomass mode it vary from 20 to 58%.This due to continuous supply of heat in biomass heater.Thus biomass mode performs better when compared to solar mode.

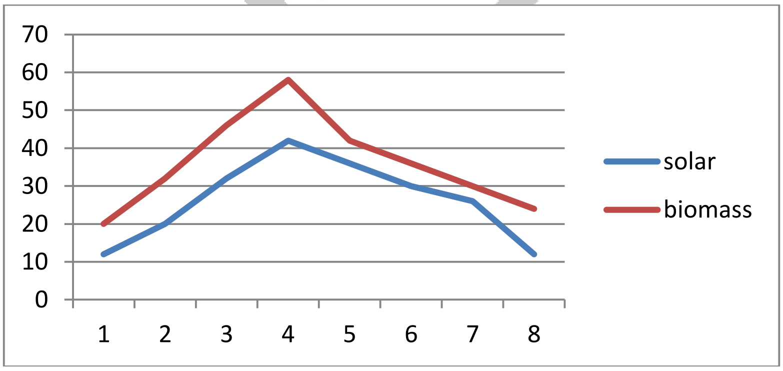


Fig.4 Effect of efficiency in solar mode& biomass

5. CONCLUSION

The present study reveals that

- The use of solar mode is advantages as it saves power and protect environment from pollution
- The biomass produces maximum temperature of 58^{0}C
- The biomass mode produces maximum efficiency
- The solar mode produces lower efficiency than biomass
- Cost of production is more in biomass mode.

- Climate does not affect the production in biomass mode

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