# Desalination Using Biomass and Solar Energy

A.Senthilrajan[1] A.Alaudeen[2]

[1]*Department of Mechanical Engineering, Mohamed sathak Polytechnic Kilakarai, Tamilnadu, India – 623806*

[2]*Principal, Department of Mechanical Engineering, Mohamed sathak Polytechnic Kilakarai, Tamilnadu, India-623806*

***Abstract-In this work a single basin solar still is, used to produce distilled water using biomass heat source, solar energy. The concept of integrating the single basin still with biomass heat source is introduced in this research study. The heat exchanger is connected to the biomass boiler increases the water temperature in the still and also increases the productivity in the still. A conventional still is also tested with the modified still for comparison. Different solid heat storage material, Latent heat storage material are introduced in the shape of small billets to increase productivity. Glass cover cooling is performed by using manual sprinkler at regular interval of fourth dimension. Biomass are tried in this workplace. Experiments are conducted in biomass modes and solar modes. Biomass mode produces more output than solar mode*.**

*Index Terms*-**Biomass boiler, solid, sensible heat storage materials, latent heat storage, water depths. Biomass.**

## 1 INTRODUCTION

The growth of population and human, agricultural and industrial activities needs pure water. In India the storage reservoirs are minimum. 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 .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 meth odology. 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. Badran [7] has studied the performance of a single slope solar still using different operational parameters experimentally. The study also showed that the daily produc tion of still can be increased by reducing the depth of the water in the ba sin. Aybar et al. [8] found that length of an absorber plate leads to an increase in the rate of evaporation. They tested the system with black-cloth wick and black wick. They found that the fresh water generation rate in creased two to three times when wicks were used instead of bare plate. Murugavel et al. [9] fabricated a basin type double slope solar still with mild steel plate and tested with minimum mass of water. Different wick materials like light cotton cloth, sponge sheet, coir mate and waste cotton and tested with three variants, base plate, black cloth, and wick.. Fath and Hosny [10] analysed the thermal performance of a single sloped basin still with an inherent built in condenser to improve condensation rate. The lower portion of the basin fitted with a heat exchanger and coupled with a biomass boiler. The biomass boiler acts as a heat source to supply continuous heat into the basin. Sensible and latent heat storage materials are used in the lower and upper basins to increase water temperature. Various water depths of 2cm were analyzed. Various combinations of sensible, latent heat, evaporation materials, and latent heat materials are used in the form of billets in the still to increase productivity. Glass cover cooling is provided with the help of manual sprinkler at regular interval area sponges, are used along with sensible and latent heat storage materials. The performances of still with biomass boiler are compared with the performances of conventional still.

2. Experimental set up

A single basin solar still was fabricated with 1.5mm thick mild steel. The size of the basin was 1x 1.4 x 0.5m. The lower basin was fitted with 12mm diameter G. I heat exchanger having 8 numbers of turns the basin is painted black to absorb maximum solar radiation. The position and bottom positions of the stills were insulated with 3mm thick thermocouple insulation layer (0.015W/m-K thermal conductivity) to reduce heat losses. The condensing surface is made of plain glass with 3mm thickness is set at 300 inclination to the horizontal axis. A rubber sealant is applied to keep the glass intact with the steel to prevent the vapor leakage from the still. Collection troughs were provided at a lower place the lower borders of the cover, to collect the condensate. Distillate outlets were provided to drain the water through hoses and to store in jars. Provisions were made to supply raw water, run out the basin water and insert thermocouples. The biomass boiler having 130mm outer diameter and shell thickness15mm and height 650mm made of cast iron was used as a high temperature source. The boiler is internally fired with locally available biomass materials. The feed water 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 present in the boiler

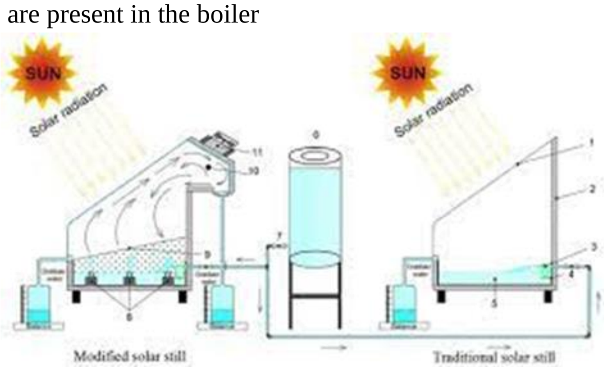


Fig.1 Experimental setup

3. Working

Solar still is supplied with 2cm depth of water through the inlet pipe in the still. Biomass boiler was filled with feed water supplied from the inlet supply tank. Biomass having 1kg of mass are fed inside the fur nace through the fuel supply door and ignited manually. Water in the drum gets heated the burnt gas passes through the inner side of the fire tube and exhausted to the atmosphere through the chimney. The boiled water is distributed inside the solar still through the heat ex changers and the circulation pump. The water inside the solar still absorbs heat from the heat exchangers and evaporated into vapors reaches the bottom surface of the cover. The top surface of the basin was Cooled externally the vapor condenses and collected in the condensate collection channel as distilled water. A collection flask collects the distilled water. Water circulation and the burning process in the boiler continuous through circulation pump at constant speed. In the solar mode the still is exposed to solar radiation only. Fig.1 indicates the experimental setup.

4. Modifications

i. Modes of operations

Several forms of biomass fuel such as wood chips and palm wastes are applied in the biomass boiler as fuels. The still was operated without bio mass boiler and with biomass boiler. The conventional still also run in series with the modified biomass still for comparision.

ii. Glass cover cooling

Glass cover cooling increases the compression process. Hence cooling methods such as manual spraying of water at regular interval of time on the glass cover reduce glass temperature.

III. Sensible heat storage sensible heat storage material such as granite pebbles, were trying to increase the water inlet temperature

iv. Evaporative area To increase exposure area sponges, were introduced in the watershed.. All the exposure materials are of area 0.5x0.5m placed 20% in the water surface.

5. Results and discussions

5.1.Effect of sensible heat storage materials on productivity

Sensible materials can store more amount of heat energy and increases the heat capacity of the basin in addition to increasing the basin absorption. These materials absorb energy during heating periods and released energy slowly during cooling. The Fig.2

shows the productivity of various solid sensible heat storing materials with time various material such as marble pieces are placed inside the still with 2 cm water depth and tested in both biomass and solar mode. The productivity of pebble pieces are 38%more than conventional still (790ml/hr) and 54% more in biomass mode. The productivity is taken for average solar radiation of 400-900

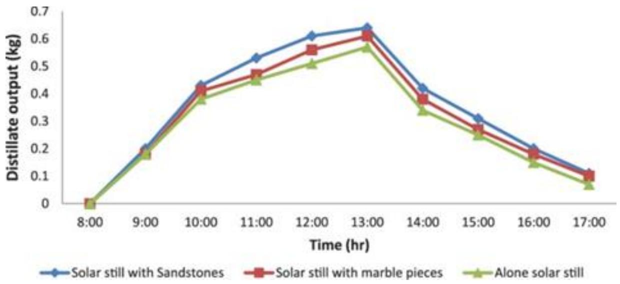


Fig.2 Effect of sensible heat storage materials on productivity

5.2 Effect of evaporative surfaces on productivity

Due to capillary action sponges, absorbs more water. Thus exposure area is increased which leads to increase the evaporation rate in the still. As shown in Fig.8 Productivity is increased by about 34 % for sponges than conventional still and 45% in biomass mode. The readings plotted on theFig.3 is taken for the average wind velocity of 1.8- 2.9m/s on various days of test trails.

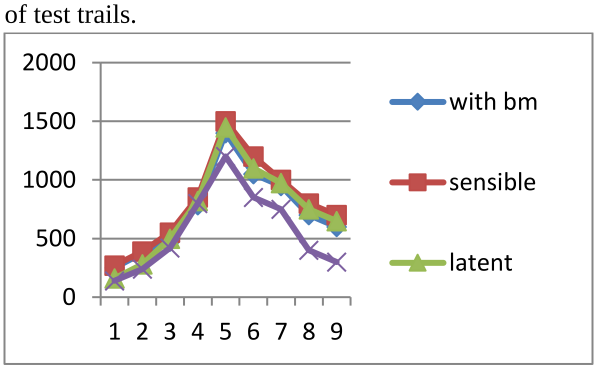


Fig.3 Effect of evaporative surfaces on productivity

5.3 Effect of Latent heat storage materials

The Fig.4 shows the productivity of the various latent heat storage materials in solar mode. Various solid materials such wax are packed inside the billet and introduced into the still. The latent heat materials having a property of changing their phase from liquid to vapors during charging periods and from vapors to liquid phase again during discharging periods. During the charging periods it absorbs energy and releases during discharging. The productivity of glycol is 40% higher than conventional still. Similarly the productivity was 58% higher than the conventional still in biomass mode.

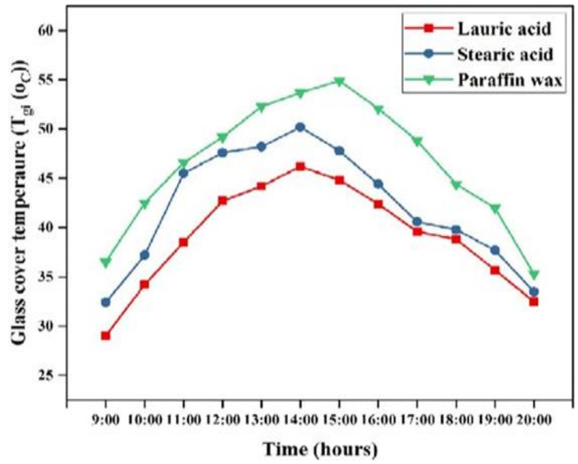


Fig.4. Effect of Latent heat storage materials

5.4 Temperature reduction using cooling water

The amount of water produced from the solar still depends upon the parameters such as wind velocity, relative humidity, and ambient temperatures. If the wind velocity is higher it cools the glass cover quickly than at lower velocities. Lower ambient temperature also cools the glass quickly. lower relative humidity results in decreasing the sky temperature and increases the cooling process. In this work water is forced by the pump and sprays as a jet on the glass cover

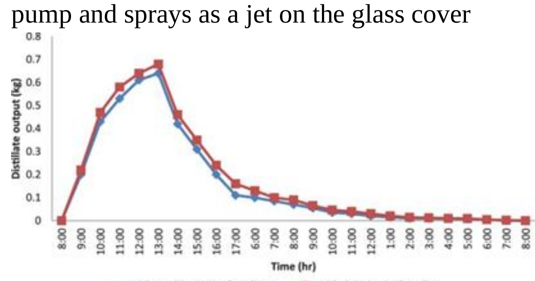


Fig.5.Effect of glass cooling

6. Conclusions

An experimental work has been conducted to predict the productivity of a single slope solar still coupled with biomass boiler using different solid, liquid sensible heat storage mediums and various evaporative materials. Based on the experimental results the following conclusions are made. An increase in the still productivity was observed with the increase in the energy supplied by the biomass boiler. The productivity of the still coupled with biomass boiler does not depend on solar radiation. Changes in solar radiation do not affect production. Solar still behaves as condensing unit. Water production is made constant if continuous burning inside the boiler. Biomass is Eco friendly. The yield can be increased in proportion to increase in inlet water temperature. Use of sensible, latent heat storage materials in the still improves productivity by 73% than conventional still. Evaporative surfaces cover cooling increases productivity

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