

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 2, February 2016

Enhancing the Productivity of the Single basin Solar Still with Energy Storing Materials

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ABSTRACT: A single basin single slope solar still with 0.85m x 0.81m x 0.7m has been fabricated with G.I sheet and tested with different water depths of 1,2,3cm. Various solid and liquid sensible heat storage materials, Evaporative surface materials are used in the form of billets, in the still. To reduce glass cover temperature the outer glass was cooled by using sprinkler manually at regular interval of time. Theoretical analysis was performed and compared with experimental values. The performances of modified still were compared with conventional still of same size running under the same meteorological conditions. The solid sensible heat storage materials produces 58% more productivity than conventional still. Liquid sensible heat storage material produces 21% more than conventional in till. The payback period of the still was 345 days.

KEYWORDS: solid sensible heat storage materials, liquid sensible heat storage materials, Glass cooling, Evaporative surfaces, water depths

I. LITERATURE SURVEY

Fresh water is one of nature's most important gifts to humanity. It is indispensable to life as a person's survival depends on drinking water. The gulf and North African region are recognized as a foe lack of new water resources. Solar desalination is the best method for purifying the impure water in a low plate Solar distillation method is the cheap for producing more water. The solar stills have many advantages than other methods of desalination. Rai et al. [1990] studied the operation of still with the flat plate collector and predict the productivity decreases with the salt concentration. Badran & Tahaneih [2005] studied the effect of coupling a flat plate solar collector with the still to increase the productivity by 36% Bassam & Hamzeh [2003] have done the experimental study with different sponge cubes in basin and improves the productivity by 18% to 27.3%. Voropolulos et al. [2004] investigated the hybrid still coupled with heaters; the results showed that the productivity is doubled by coupling. Benon Bena & Fuller [2002] coupled a natural convection solar dryer with a biomass back up heater and increases four times better than the solar dryer. Nakatake [2009] increase the productivity by using external reflector in the solar still. Muafag Suleiman & Tarawneh [2007] uses sprinkler for glass cooling to reduce glass cover temperature and improves productivity of 14% more than conventional still.

II. WORKING

Single basin single slope solar still was fabricated with 1.4mm thick mild steel. The size of the basin was 0.81 x 0.82 x 0.75m. The basin is painted black to absorb maximum solar radiation. The side and bottom sides of the stills were insulated with 4mm thick thermocol insulation layer (0.15w/mk thermal conductivity) to reduce heat losses in the still. The condensing surface of the still is made of plain glass with 4mm thickness is fixed at 30° inclination to the horizontal axis. A silicon rubber sealant is used to hold the glass intact with the still to prevent the vapor leakage from the still. Collection troughs were provided below the lower edge of the glass cover to collect the condensate. Distillate

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outlets were provided to drain the water through hoses and to store in jars. Provisions were made to supply raw water, drain the basin water and insert thermocouples. Fig.1 shows the photographic view of be fabricated experimental single basin solar still. A conventional still of same area was fabricated and run parallel with the modified still for comparison. Experiments were conducted at Mohamed sathak polytechnic college, Kilakarai, Ramanathapuram, Tamil Nadu, India during the months of may -june , 2017. The readings were taken from morning 9.AM To Evening 5.PM for every one hour interval. Pv sun meter, digital anemometer and mercury thermometers were used to measure global radiation, wind velocity and ambient temperatures respectively. K-type thermocouples with multichannel digital display unit were used to measure basin, water, glass cover temperatures.

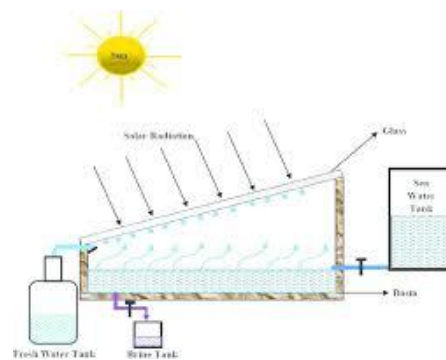


Fig.1 experimental setup

Sensible heat storage

Several types of sensible heat storage materials such as rocks, metals, pebbles were trying to increase the water inlet temperature. Metals pieces having $0.8 \times 0.4 \times 0.04$ m area was ordered at regular intervals in the stack. The total masses of metal pieces are 0.5 Kg. leather pieces having area $0.5 \times 0.5 \times 0.01$ m was placed at regular interval in the still. pebbles having dimensions 0.02m diameter was identified inside the still. The volume of pebbles are 1.5 Kg. The specific heat capacity of rocks, metals, pebbles are 0.75, 0.54, 0.64, KJ/Kg-K.

Latent heat storage materials

In order to increase the water temperature various materials such as wax, water are used in the form of billets. The spots are having diameter 0.02 m and length 0.04 Pellets are made of GI sheet metal. All the fabrics are stored half of the volume inside the billet. The latent heat of wax, water, liquid paraffin is 647,334, KJ/Kg.

Evaporative area

To increase exposure area wick cloths, smallpots are introduced in the form of. All the exposure materials are of area 0.5×0.5 m placed 20% in the water surface. These materials lifts water by capillary action and helps to increase the exposure area in the still

. Water depth

Several characters of water depths such as 1cm, 2cm, and 3cm were introduced into the still to suss out the operation. The flock of water for 2cm water depth is 12.5kg.

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III. RESULTS AND DISCUSSION

3.1 Effect of water depths on productivity

The result of water depth in the steel basin in the productivity is shown in fig.2. It is apparent that as the water depth increased, the productivity will be diminished. This is due to be increase of the heat content of the water in the basin, results, in lower water temperature in the basin leading to lower evaporation rate. Still with 1cm depth produces a total output of 4.5 L/m² and still with 2cm depth produces 4 L/m².

Effect of solid, sensible heat storage materials on productivity

Some materials can store more amount of heat energy and increases the heat capacity of the drain area, in addition to increasing the basin absorption. These materials soak up energy during heating periods and released energy slowly during cooling. The fig. 3 shows the productivity of various solid.pebbles and rocks produces more out of 52% and 48%.

Effect of liquid sensible heat storage materials on productivity

Various sensible heat storage materials are presented inside the lines and placed inside the still and tested. Fig.4 shows the output of various liquid sensibilities The latent heat materials undergo phase change from liquid to vapor and again from vapors to liquid. During the phase changing it absorbs heat energy and transmits it to the water and increases water temperature in the still Storage materials. More output was observed in wax (42%) than other materials

Effect of evaporative surfaces on productivity

Due to capillary action clay pots, , cotton cloths absorb more water. Thus, exposure area is increased. This contributes to increase the evaporation rate in the steel. As demonstrated in fig.5, productivity is increased by nearly 23% for clay pots and 14% for cotton fabrics. The evaporative surfaces raises water through capillary action and deposited as water vapor in the bottom parts of the ice screen and increases the productivity in the blade.

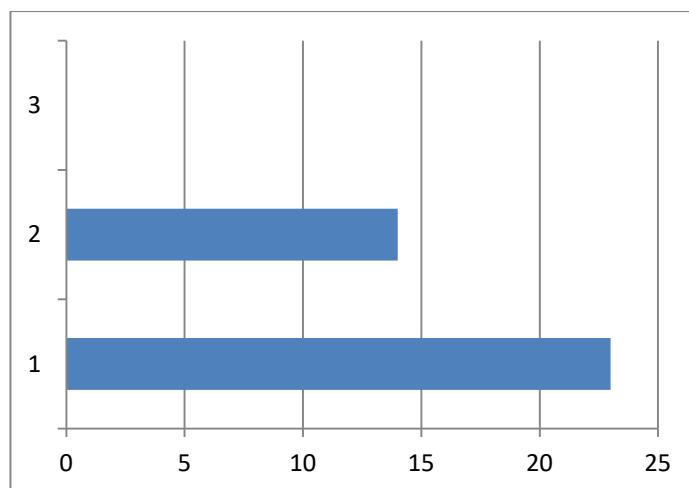


Fig.2 Depth Vs output

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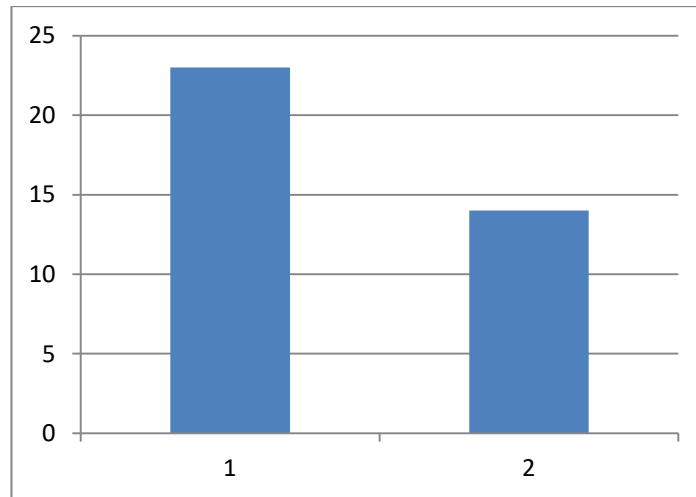


Fig.3 Effect of sensible materials

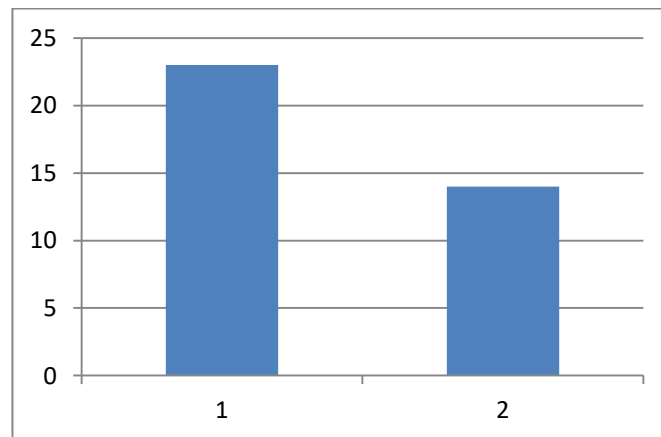


Fig.4 Effect of latent heat materials

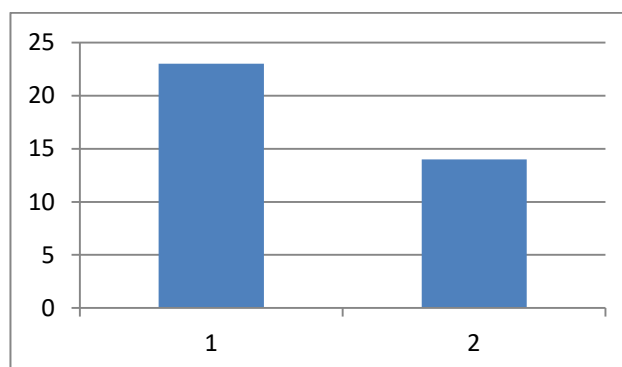


Fig.5 Effect of evaporative materials

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IV. CONCLUSION

An experimental study has been carried on to predict the productivity of a single slope, solar still using different solid, liquid sensible heat storage mediums and various evaporative materials.

Established on the experimental results the following determinations are reached

- Changes in solar radiation do not bear on yield.
- Solar still behaves as condensing unit.
- Cost of water production is low.
- The yield can be increased in proportion to increase in inlet water temperature.
- Use of solid, sensible heat storage materials in the still improves productivity by 58% than conventional still.
- The liquid sensible heat storage materials in the form of billets increase the productivity by 42% than conventional still.
- The used of evaporative surfaces increase the area of exposure and still productivity by 21%
- Lower water depth in the still increases the productivity in the still.

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