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Research Article

PERFORMANCE ANALYSIS OF SINGLE SLOPE SOLAR STILL

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Abstract- Solar still is the one of the cost effective method of producing pure water using solar distillation techniques. Solar still uses heat energy as input which is obtained from solar radiations. Water is essential to human life for survival and good health on earth and access to safe water is a major challenge in many communities in the world. As world population and social-economic growth, societies are challenged to provide fresh water to meet those needs for all of their people. Growing demands of freshwater resources are creating an urgent need to develop self sustained system to meet the demand of fresh water. Among the conventional distillation process, solar desalination process seems to be a suitable solution for resolving this existing demand of fresh water. Solar water distillation removes impurities such as salts and heavy metals as well as eliminates microbiological organisms.

Keywords- water, solar radiation, solar still, collector, design of solar still.

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Introduction

Now days, lack of drinking water is major problem in most of the countries. Most of the water resources are under the stage of depletion. Solar still is an economical and easy method for production of pure water. Evaporation and condensation are the basic principles used in solar still. The impure water in the solar still is heated by solar radiations that penetrate through the glass cover this causes water to evaporate. Due to temperature difference between water and glass cover the water starts condensing at glass cover leaving all contaminants in the basin. The need for safe, clean drinking water is increasing rapidly. The availability of clean portable water is a major problem faced by the humanity in last few decades all over the world. It is estimated that out of 1,62, 000 of 5, 75, 000 Indian villages alone face the problem of brackish or contaminated water [9]. There is need of major development in the solar distillation as solution to this problem. Therefore, research and development of solar still is one of the ways to provide a sustainable source of potable water in Indian contex.

Materials and Methods

The all materials required for the present investigation were collected from the local market. The solar still basins were fabricated from the local fabricator workshops in the Aurangabad city. The PVC pipes and U Channels for trough were purchased from the local market. The M-seal was used as sealing material to make the basin water-tight to control the evaporated water drops. Selected physical parts of solar still like still basin, transparent top, condensing arrangement, trough, insulation etc. were constructed and tested for solar distillation process. The rectangular plates were cut at the diagonals to prepare a tray shape and welded to form a water holding basin. The transparent glass sheet was selected for the top for providing passage of solar energy and side walls of solar still. The top rectangular roof in transparent glass and fitted with M-seal. The trough of PVC plastic was cut in U shape and vertically placed to collect the condensate and facilitate the flow to the collection container or the measurement system. The other technical details are presented elsewhere [3].

The water is fed into the basin of the still. The pure water condenses at the top surface of the glass top. The droplets of condensed top slowly run down to the U channel due to slope which was collected as output. The solar stills were initially filled with the feed water volume of 1500 ml, 1814 ml, 2104 ml and 2404 ml up-to the depth of about 2 cm. The solar exposure, temperature and volumetric measurements were continued till 5.30 pm each time on the all days of experiment. The averages of 5 readings are considered for statistical mean. The Production Rate Performance (PRP), water conversion efficiency and percentage of the water purified is calculated. The qualitative and quantitative assessment of water was carried out using standard procedures [11].

Working Principle 1

The incident solar radiation is transmitted through the glass cover and absorbed as heat by a black surface in contact with the water to be distilled. The water is thus heated and gives off water vapour. The vapour condenses on the glass cover, which is at a lower temperature because it is in contact with the ambient air and runs down into a gutter from where it is fed to a storage tank. Here condensation is not drop wise, where it is film wise, therefore condensed water along the glass cover is allowed to trap in a channel fixed as opits bottom.

Result and Discussion

Performance Evaluation of Single Slope Solar Still

From the experimental collected data and theory presented in above we carried out test results as follows:

Temperature Variation During Load Test (24-11-2017)

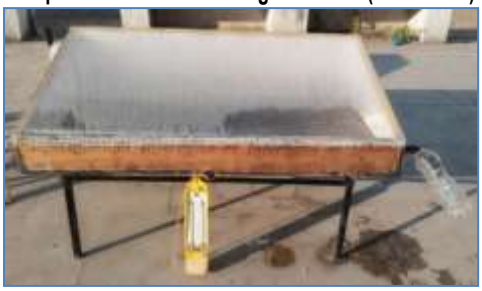

Image-1 Single Slope Solar Still

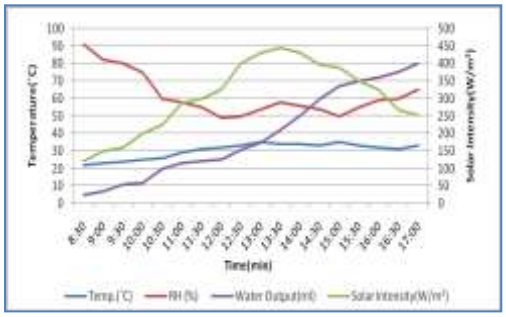

Fig-1 Average Variations in Temperature and Water Output During Load Test (24-11-2017)

The average variation in temperature and solar intensity with respect to time is shown in [Fig-1]. [Fig-1] shows that as insolation increased temperature also increased. Insolation is increased from morning to afternoon i.e. 122 W/m² to 254 W/m² at 8.00 h to 17.00 h and attain its peak value at afternoon of the day and after that it again reduced. The peak value of insolation was found to be 325W/m² at 12 h. It was observed that, the atmospheric temperature at 8.30 was found to be 22˚C,atmospheric RH was found to be 91% and solar intensity was found to be 122W/m², achieved its peak value at 12.00 h was 325 W/m², RH 49%. It was observed that water output was found to be from 8.30 h to 12.00 noon about 25 ml and from 12.00 noon to 5 h was found to be 80ml

Temperature Variation During Load Test (25-11-2017)

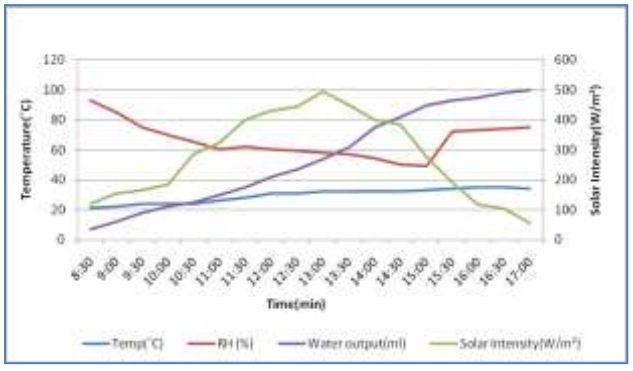

Fig-2 Average Variations in Temperature and Water Output during Load Test (25-11-2017)

The average variation in temperature and solar intensity with respect to time is shown in [Fig-2]. [Fig-2] shows that as insolation increased temperature also increased. Insolation is increased from morning to afternoon i.e. 120W/m² to 56 W/m² at 8.00 h to 17.00 h and attain its peak value at afternoon of the day and after that it again reduced. The peak value of insolation was found to be 430 W/m² at 12 h. It was observed that, the atmospheric temperature at 8.30 h was found to be 21˚C,atmospheric RH was found to be 93 % and solar intensity was found to be 120W/m², achieved its peak value at 12.00 h was 430 W/m², RH 60 %.It was observed that water output was found to be from 8.30 h to 12.00 noon about 42 ml and from 12 noon to 5 h was found to be 100ml.

Temperature Variation During Load Test (27-11-2017)

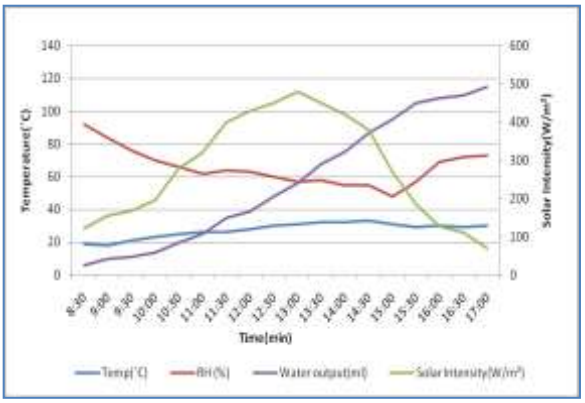

Fig-3 Average Variations In Temperature and Water Output During Load Test (27-11-2017)

The average variation in temperature and solar intensity with respect to time is shown in [Fig-3]. [Fig-3] shows that as insolation increased temperature also increased. Insolation is increased from morning to afternoon i.e. 122 W/m² to 70 W/m² at 8.00 h to 17.00 h and attain its peak value at afternoon of the day and after that it again reduced. The peak value of insolation was found to be 430 W/m² at 12 h. It was observed that, the atmospheric temperature at 8.30 h was found to be 19˚C, atmospheric RH was found to be 92% and solar intensity was found to be 122W/m², achieved its peak value at 12.00 h was 430 W/m², RH 63%.We observed that water output was found to be from 8.30 h to 12.00 noon about 39 ml and from 12 noon to 5 h was found to be 115ml.

Conclusion

The solar still distillation is one of the simple methods to remove salts and other water impurities. It was concluded that the analysis of distilled water from solar still of any size is pure. The quantity of water distilled is relatively higher in the solar still of high surface area due to higher exposure to solar radiation.

Application of Research: It a simple device to get potable/fresh distilled water from impure water, using solar energy as fuel, for its various applications in domestic, industrial and academic sectors.

Research Category: solar distillation techniques

Abbreviations,

Fig.	Figure
i.e.	That is
˚F	Degree Fahrenheit
Etc	Etcetera
Sec	Second
˚C	Degree Celsius
et.al	Et alibi (and others)
Min	Minute
H	Hour
Ml	Mililiter
pH	Hydrogen ions Concentration
Agril	Agricultural
Cm	Centimeter
M	Meter
W	Watt
PVC:	Poly Vinyl Chloride

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University: Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444104
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Author Contributions: All author equally contributed

Author statement: All authors read, reviewed, agree and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors

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