Performance Analysis of Domestic Integrated Single Slope Solar Still with and without Flat Plate Collector

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Abstract- In this paper the work is aimed to increase the awareness for enhancing quality of water supply systems in dry lands with the application of solar energy in India. The shortage of freshwater is previously observed in many parts of India, especially in rural India. The lifestyle and increasing population is also contributing to the more and more requirements of fresh water. Clean water is increasingly taking major issue on the financial and political plan, as more and more disputes arising within states, districts and even at the community level. Increasing the efficiency of solar still will reduce the problem. The present work shows the ways to improve the efficiency of solar still by adding the flat plate collector.

Key Words- Solar Still, Flat plate collector, ambient temperature.

1. INTRODUCTION

The water crisis is observed in whole world. Availability of drinking water and to provide drinking water to the community is a major concern for the governments. Water sources go on reducing day by day. This problem in not occurred naturally but man plays a major role in creating the situation. Rapid increase in population and changing ways of living also increases the need of clean water. Nearly one million children in India come to death of over-frequent, liquid waste trouble disease each year directly because of consumption of hazardous water and living in unhygienic conditions. Some 45 million citizens are acted-on by the water quality problems caused by the pollution, by more than sufficient fluoride , arsenic, and iron or by the access of salt water. Millions do not have enough amounts of safe water, particularly during the summer months.

Solar distillation is one of the processes to provide clean water free from salts It works on the simple principle of converting solar energy into heat energy. Solar still have one of the option to provide good outcome in India for lower crowd which are more than 20 km away from the starting point of clean water and where the TDS of saline water is over 10, 000 ppm or where seawater is to be desalted. The average intensity of solar radiation in India is 200MW per square kilometer.

A solar still works on the principle of evaporation and condensation. Researchers are continuously working on the methods to increase the efficiency of solar still. V Ramanathan.V et al [1] conducted experiments to increase the productivity of solar still by adding a flat plate absorber. The flat plate absorber is placed in such a way that it is parallel to the glass cover of the solar still so as to maximize the absorption of solar radiations. By this modification, the maximum temperature of the absorber plate achieved was 95°C in comparison to 67°C of the conventional solar still. Experimental results of modified solar still were compared with conventional solar still. It was found that distillate output increased by 25% with a flat plate absorber when compared to conventional still. Rajaseenivasan.T et al[2] conducted experiments on solar still with flat plate collector. Two different setup were prepared , one single slope still and another one with flat plate collector. The flat plate collector basin with almost 60% higher distilled water as compared to other.

2. Experimental Setup

A domestic type single slope solar still of 23^o inclination is designed, according to the latitude of Betul. The base of both solar stills is of dimension 1000×1000 mm. The entire still is covered by a PVC sheet while the upper surface is covered by a toughened glass. It is portable and easy to handle.

The single slope solar still has the following components

- Basin
- Toughened Glass
- Distillate trough
- Water inlet and outlet

3. Flat plate Collector

The flat plate collector is one of the most popular and economical solar energy collection system designed for operation in the low temperature range (ambient 60^{o}C) or in the medium temperature range (ambient 100^{o}C). It absorbs solar energy, converts it into heat and then transfers the absorbed heat to a stream of liquid, i.e. water. It absorbs both beam and diffuse radiation. It does not require tracking of the sun and requires little maintenance.

The flat plate collector has the following components

- Glazing cover
- Riser
- Header
- Absorber plate
- Bottom glass wool insulation

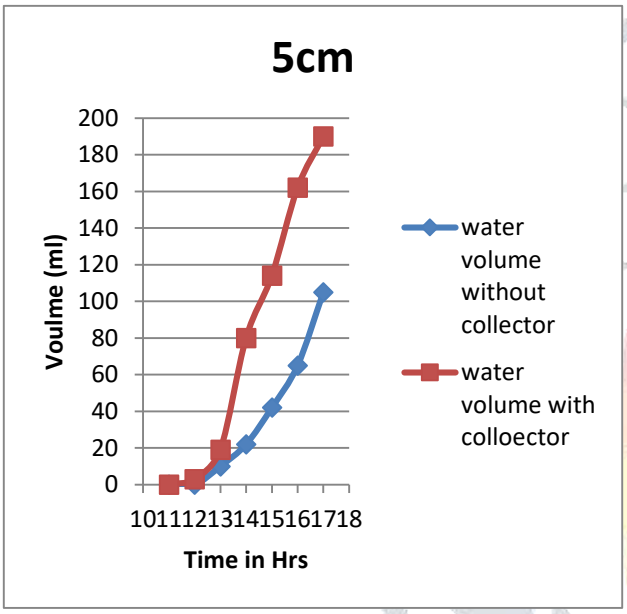
The set up for the conduction of experiments was set up at Betul. The setup is installed in the open ground so that there

will be no barriers in the sunlight coming from the sun. The flat plate collector and still was inclined at (23°) to absorb maximum radiations. The experiments were conducted in the month of April and May.

The experiments were conducted for water depth of 5cm, 10 cm and 15 cm and from 11:00 hrs to 15:00 hrs. The readings were taken for three consecutive days one without collector and one with collector. The observations were recorded in the form of tables and analysis was carried out to find the yield.

4. Results and discussion

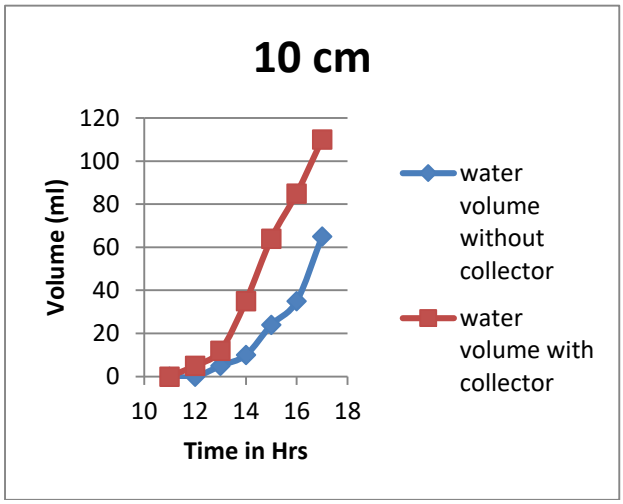
1. Effect of yield on 5 cm water depth on still with and without collector.



Graph 1: Variation of yield on 5 cm water depth for single slope solar still with and without collector

Graph shows the variation of yield for a single slope solar still for a 5 cm water depth at inclination angles of 23° with and without collector. It is observed that the yield using the flat plate collector is approximately just double to that of without collector as the case of preheating of water occurs resulting more yield. During the period from 11:00 hr to 15:00 hr there is low yield of m_{wc} and after that sudden increment also observed and 15:00 hr achieved maximum. A total yield of 244 ml and 568 ml without and with collector were obtained respectively. Result shows the effectiveness of the flat plate collector to increase the efficiency of the system.

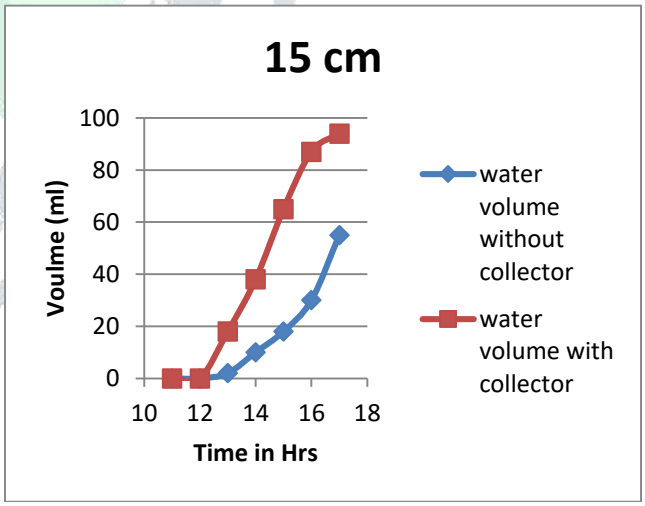
2. Effect of yield on 10cm of water depth on still with and without collector



Graph 2: Variation of yield on 10 cm water depth for single slope solar still with and without collector

Graph 2 shows the variation of yield for a single slope solar still having 10 cm water depth at inclination angles of 23°. The yield of solar still with collector is observed more as compared to solar still without collector. Total yield and is obtained 139 ml and 311 ml without and with collector respectively. The total yield also decreases in the both cases due to increase of water depth as 10 cm because more water requires more heat energy for heat gain.

3. Effect of yield on 15 cm of water depth on still with and without collector



Graph 3 Variation of yield on 15 cm water depth for single slope solar still with and without collector

Graph 3 shows the yield of water with respect to time for a single slope solar still for a 15 cm water depth at inclination angles of 23°. In both cases, both day climatic conditions were clear sky that's why yield obtained was good. But due to increase of water label as 15 cm yield is less as compared

to 10 cm and 5 cm water depth. The yield obtained 115 ml and 302 ml without and with collector respectively.

5. Conclusion

1. It has been observed that the lower water depth in still tends to rapid rise in temperature of water and high evaporation rate in solar still. This increases yielding of water.

2. It has also been observed that yield increases by the use of flat plate collector as compared to that of without collector as the case of preheating of water was done resulting more yield for a 5 cm water depth. A total yield and is obtained 244 ml and 568 ml without and with collector respectively. Furthermore it has been seen that the efficiency of system increases with the use of flat plate collector.

3. It was also observed during the conclusion that the yield of solar still with collector is more than that of solar still without collector for having 10 cm water depth. Total yield and is obtained 139 ml and 311 ml without and with collector respectively. Total yield obtained is almost doubled with the use of collector. The decrease in total yield is also obtained in the both cases due to increase of water depth at 10 cm because of the grater water level in the still.

4. It has been observed that good yield is obtained for the both case of 15 cm water depth, since climatic conditions were good. But due to increase of water label as 15 cm yield is less as compared to 5 cm and 10 cm water depth. Total yield and is obtained 115 ml and 302 ml without and with collector respectively.

5. It has been concluded that the highest yield is obtained with water depth of 5 cm and the use of flat plate collector, which is almost double as compared to without flat plate collector. After experiment and observations it is conclude that solar still becomes more efficient with flat plate solar collector at any water depth label.

A solar still may be used in villages and mass production of fresh water. Globally the problem of impure water is rising day by day hence there is huge chance to produce fresh water by using solar still, and in special situation a solar still can provide fresh water economically than any other method. The solar distillation process requires low grade energy which is freely available and also here is no greenhouse pollutant as in the case with other purification techniques using fossil fuels. In future it can be used in remote places where there is no electricity and fuels.

6. Future Scope

There is always scope for the improvements that could be implemented to enhance the design and performance but due time restriction during project it has not been possible. These suggestions are recommended for any future work to be conducted on the solar still for desalination purposes-

1. In the present study single slope solar still is used to conduct the experiments, the design of solar still can also be improved by using double slope solar still.

2. In the present experiment setup flat plate collector is used to increase the overall efficiency of the system, in place of flat plate collector parabolic or concentrating collector can also be used which are more efficient that flat plate collector.

Computer simulation can be applied for simulating evaporation process through new solar still designs. Designs of solar still can be improved further by changing different cross sections like rectangular or cylindrical or by changing the shapes of condensing cover.

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