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An Experimental Analysis of Hybrid - Pyramid type Solar Desalination with Concentric Parabolic Collector (CPC)

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Abstract: ***Solar energy is a suitable green technique for purifying brackish water and also for rejecting salts from saline water. This paper deals with the experimental studies and performance analysis of Hybrid pyramid type Solar Desalination with Concentric Parabolic Collector (CPC).The data have been collected for the composite climate condition of Coimbatore. In this paper, we made comparisons and the performances of still with the collector and without the collector. To increase the distillate output of the solar still is our ultimate aim and this can be achieved by either increase the water temperature or decrease the condensing cover temperature. Here we are increasing the water temperature by using parabolic collector. The still with the collector gives higher productivity than still without collector and it is the best solution for lack of potable water in remote regions.***

Keywords: Solar still; Hybrid desalination system; solar energy; Pyramid solar still; concentric parabolic collector.

I. INTRODUCTION

Water is the most important substance in a life of all survivals. When the population of world increasing rapidly the demand of potable water is also increased more. So the freshwater scarcity is associated with large quantity of solar resources. It seems also logical and attractive to associate those two parameters for countries where grid electricity is not spread widely and with easy access to seawater or brackish water. It is not a new concept or an idea and it has been known for many ages, antique sailors used to desalt water with simple and small sized solar stills during that period. It's also a fact that production of fresh water requires a large amount of energy as a 1000 m3 of freshwater per day which requires 10,000 tons of oil/year.

The solar energy is also termed as 'Free Energy' and the solar desalination water is a promising alternative solution for supplying relatively to small communities, remote areas or islands with fresh water. Solar stills present some specific advantages for their use in these areas such as ease of construction using locally available materials, minimum operation and maintenance requirements and friendliness to the environment. Their main disadvantage, however it is the low output in distilled water when compared with other desalination system technologies. However, it has been proven that an increase of saline water temperature leads to significantly higher outputs.

The sun gives us life and energy, today our thirst for newer clean renewable sources of energy.

Our nation is blessed with large amount of solar energy; it receives solar radiation for at least 300 days in a year i.e. more than 3000 h of sun shine in a year, almost all regions of India receives more than adequate solar radiations. The annual average of direct normal irradiation varies within India like Rajasthan; Karnataka and Tamil Nadu region receives highest DNI annual average. In India we have the average daily solar radiation is 4–7 kWh/m2 when compared with the global average solar radiation of 2.5 kWh/m2 .Some of the countries like Australia, South Africa, Chile, Mexico, Algeria, Libya Egypt, Namibia, Botswana and Zimbabwe receives highest solar energy. For regional average South Asian region is after Middle East, North Africa region in between tropic of cancer and tropic of Capricorn region receives highest solar energy isolation. The water demand is increasing rapidly than the sustainable level and desalination is the best method to provide the shortfall of water in future.

There are various alternative renewable sources for the desalination. Among all those solar energy has the potential which gives future energy demand. Due to increase in population of developing countries need for the potable water is also increased. The application of solar energy includes power production, heating of water in the domestic sector and health institution as one of the popular devices that harnesses solar energy which is the replacement of electric water heater and its system is called solar water heating system Therefore, solar heating system driven/assisted desalination is becoming more viable despite its high capital cost, this paper provides a view of solar collector in solar water desalination systems and its applications.

II. PRINCIPLE OF SOLAR STILL

Solar Still is a device which is uses the principle of hydrological cycle. In this cycle, the water stored in the basin can get evaporated due to evaporation process. The evaporation process takes place due to solar radiation from the sun. The water used in the basin is brackish water or seawater. During evaporation process, the brackish water gets converted to pure water. The impurities present in the brackish water left behind in the basin. The evaporated water gets converted into small droplets when it gets touched with the glass surface of the still and it can be collected out.

A. Benefits of Solar Distillation

1) Solar Energy is free from pollution
2) It is cost effective
3) It uses very less energy than other methods to purify
4) There is no need of any skilled labor
5) There is no need of any fuel supply and its interruptions

III. CLASSIFICATION OF SOLAR STILL

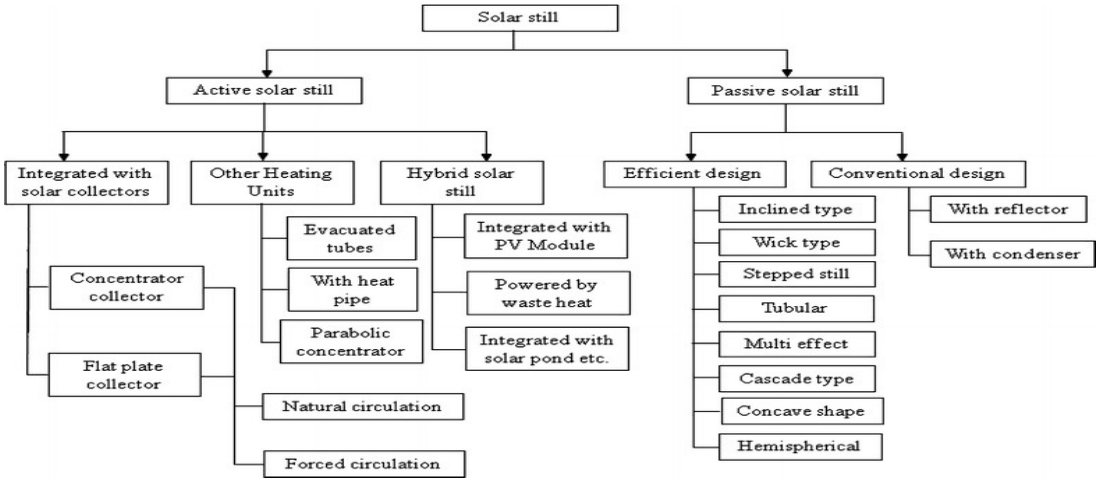

Figure 1: Classifications of solar distillation system

IV. EXPERIMENTAL SETUP

The Experimental setup consists of Storage Tank, Concentric Parabolic Collector, and Solar basin with Pyramid Shaped Glass cover. The Storage tank consists of 250*250*250 mm area and it is provided with a stand for easy water flow.

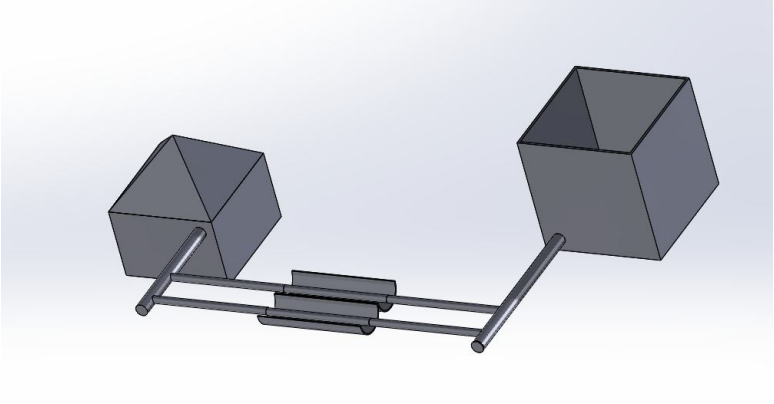

Figure 2: Schematic view of Experimental Setup

The Concentric Parabolic collector consists of 250 mm SS sheet which is to be turned to a semicircle shape. The pipe which is used here is made of Copper and it is easy to absorb the radiation from the sun. The CPC which is used to preheat the water from the storage tank and it is passed to the main solar basin. The main solar basin consists of 250*250 mm area and it is having Pyramid

shaped glass cover which is placed over there. The Pyramid type dome shaped structure is used to absorb radiation from the sun. The water in the solar basin gets evaporated and it gets deposited in the glass situated area and it can be taken out. The CPC which is used to increase further the temperature of the water and it is easily gets evaporated in a very fast manner.

Figure 3: Pictorial view of Experimental Setup

V. RESULTS AND DISCUSSION

The testing of varies parameters such as temperature, solar radiation and distillate yield rate with respect to time can be taken and analyzed to get the desired results. The figure 4 shows the graph of solar radiation with respect to time from 8AM to 5PM. The graph clearly shows that the radiation having peak at 12 to 1PM. It gradually increases from 8AM and reaches peak at 1PM and gradually decreases. So, there will be maximum output will be produced during peak hours of 12 to 1PM.

The figure 5 shows the graph of varies temperatures with respect to time from 8AM to 5PM. The graph clearly explains the variation of different temperatures with time variations. The graph consists of temperature ratings of both with CPC and without CPC. The water temperature with CPC is very high than the temperature without CPC because the CPC will preheat the water with the help of solar radiation from the sun.

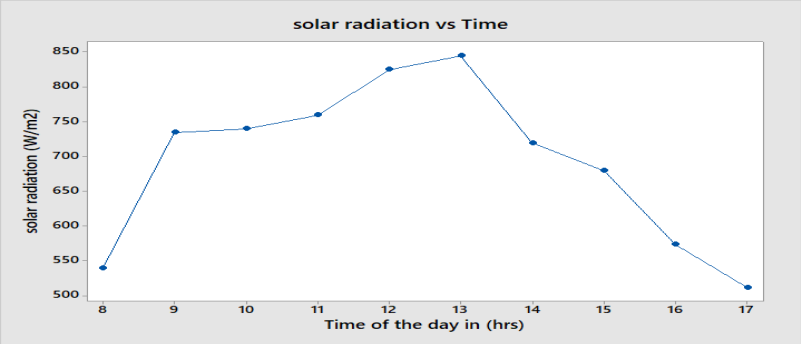

Figure 4: Graph of Time vs solar radiation

Due to that there will be enhanced temperature difference between with CPC and without CPC. Also the glass cover temperature is purely depends on the solar radiation from the sun. The temperature having peak at 1PM and it will gradually decreases.

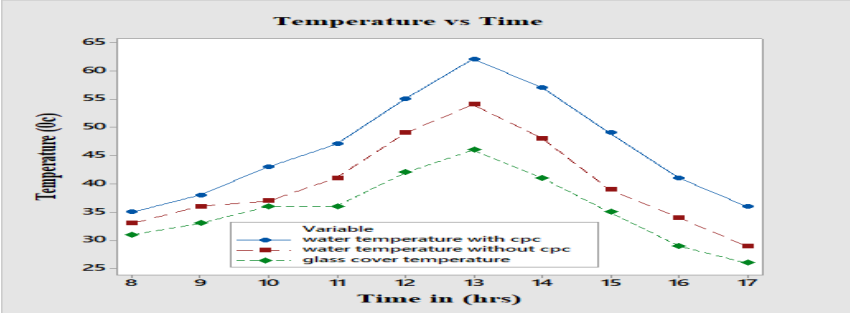

Figure 5: Graph of Time vs Temperature

Figure 6 shows the graph of distillate yield rate with respect to time variations. The graph clearly view the different yield rate of solar still with CPC and without CPC. The still with CPC gives greater yield rate than the still without CPC. The yield rate gives the distillate output of the solar still and it is taken in hourly basis. The yield rate gradually increases and attains its peak at 12 to 1PM and gradually decreases. The yield rate depends upon the solar intensity and also the area of the solar still.

The Temperature and solar radiation are very low in morning timings and then it increases and attains its peak and it slightly decreases and withstands till 5PM. The yield rate also very low in the morning and attains its peak and slightly decreases. Then the overall performance of the solar still with CPC gives greater output than solar still without CPC.

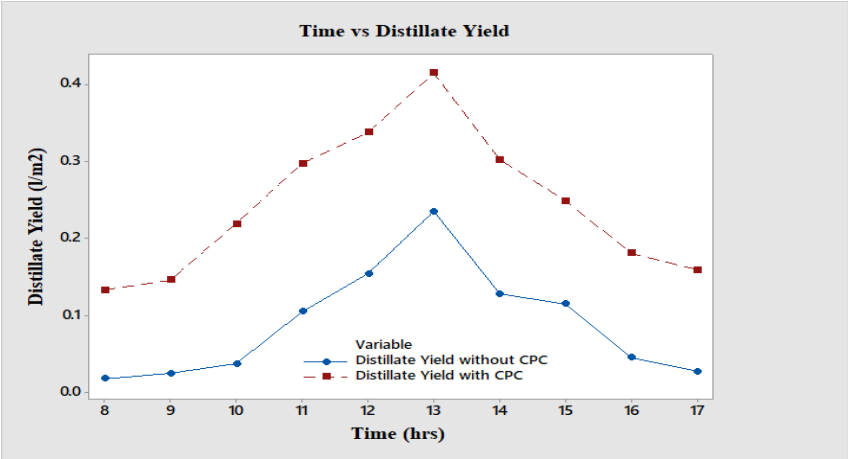

Figure 6: Graph of Time vs Distillate Yield

VI. CONCLUSION

Thus the pyramid shaped solar still with CPC and without CPC have been experimented and analyzed. The solar still with CPC gives greater distillate output than the still without CPC. Also both the pyramid shaped type gives better output than conventional solar still. The heat transfer from basin to glass cover that is from evaporative region to condensing region have been very low in morning and very quick in peak time and gradually decreases in the evening. The area of the solar basin plays a major role in getting the output. Further the solar still yield rate can be improved by increasing the area of the basin. Also by using heat storage materials the heat can be withstand for long hours and then by increasing the productivity. There also by use of PCM materials to get better productivity. Thus the Pyramid shaped solar still with CPC gives greater output than the solar still without CPC.

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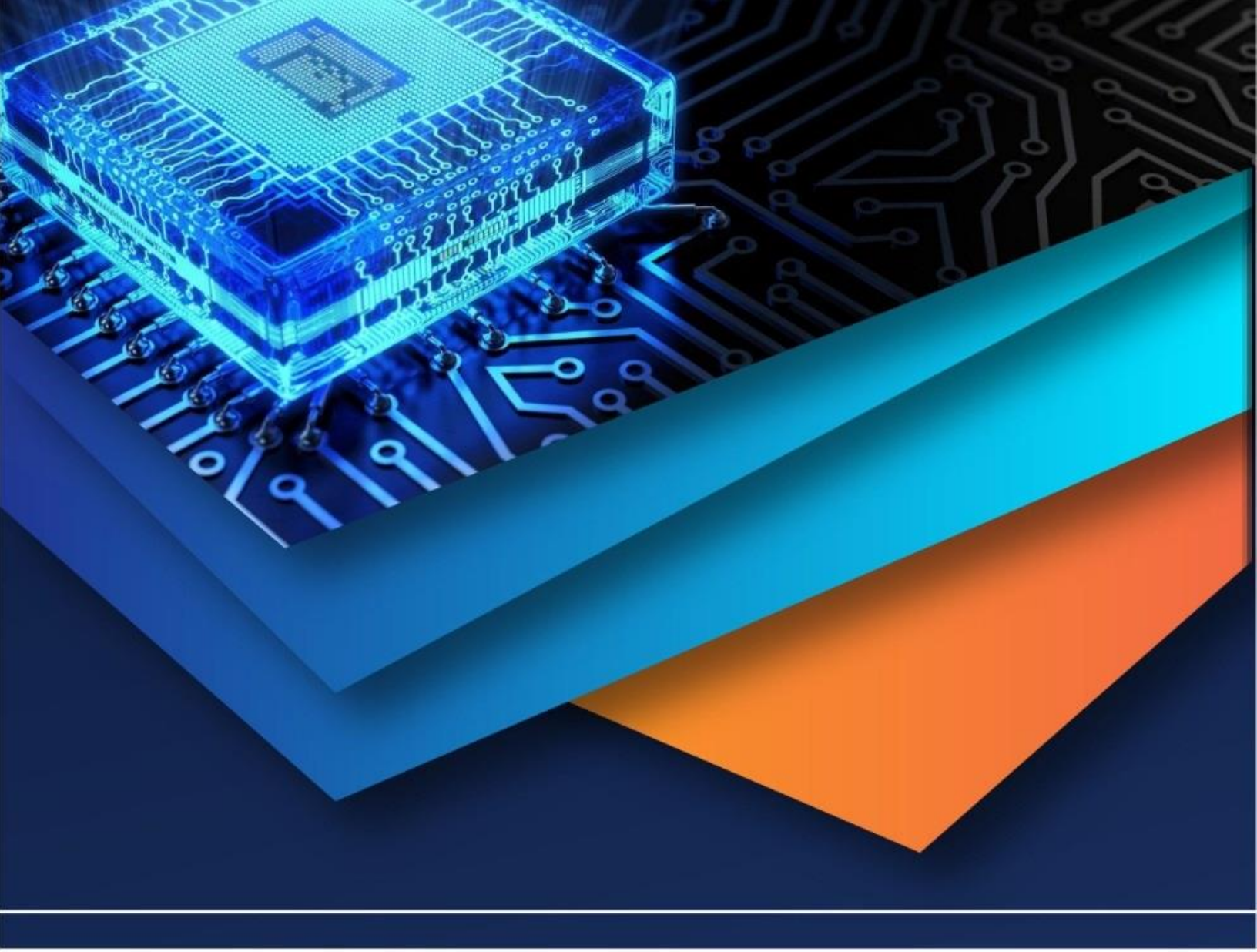

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