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Enhancement of Production rate of Distilled water in Solar Still.

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Abstract: -- As the human population, industrialization and modernization increases day by day. The condition of consumable water becomes miserable. So it becomes our primary objective to get consumable drinking water, with the lowest possible cost, without suffocating the conventional source of energy (like- coal, electricity). In this way solar distillation system (solar still) seems a very promising method to get consumable drinking water with lowest possible cost and without polluting environment. Although the concept of solar distillation is not new, again lot of research has been performed to get the highest possible distilled water from the solar distillation system. To increase the production rate of solar distillation system, an experiment has been performed regarding this; we use already heated water from evacuated tube solar water heating system to the solar distillation system incorporated with the fan powered by solar panel.

Keywords: solar still, evacuated tube solar collector, distilled water, fan.

I. INTRODUCTION

We know that average human adult male body contains 60% of water and average human adult female 50% by weight. Again even blood is made up of 82% water. The written percentage number is enough to explain the importance of water in our body. Although 71% of water in the earth but the major part of this water is in the ocean and very few percentage of water is present in our glaciers, rivers, lakes, and ground water .Now a days due to rapid increase in population, industrialization, and modernization two major circumstances created; first one is the shortage of water and second we got contaminated water from existing water sources. This pollutant may be excess amount of chloride, fluoride again presence of heavy metal like arsenic, lead etc also found in some water samples; which may cause the major disease to our body. To avoid all such circumstances we need to purify the water. Many water purification techniques already existed including reverse osmosis, activated carbon, and ultrafiltration techniques etc. But all of these techniques contain major shortcomings like they cannot work without electricity and also expensive. Again we know very well that major part of electricity is produced by burning of fossil fuels, which leads to environment pollution. In this way the solar distillation arises a new hope .through which we can purify water without the use of electricity. Solar distillation system utilizes the solar energy to purify the water. A.E. Kabeel et al. (2012) experimentally investigated the performance of solar still with different rotation speed of fan at different water depth of saline water and got increase in productivity. Ragh et al. (2013) performed an experiment in which they integrate evacuated tube collector to solar still of 0.03m depth they investigated the decreases in production of distilled water with increase in depth. Hitesh et al. (2016) performed an experiment in which they coupled the evacuated tube collector with the solar still. The evacuated tube increases the temperature of solar still again they performed well during evening and some short of night due to energy storing capacity and they got an increase in distilled water productivity. In this prospective, we performed an experiment regarding solar still to enhance the productivity of water at Birla Institute of Technology, Mesra Ranchi India (latitude - 23°45´N and longitude - 85°30´E). We construct solar still made of galvanized iron sheet is insulated with thermocol and ply wood and is painted black for good radiation absorption. In between the solar still we incorporated a fan (with varying speed).

II. FABRICATION

A typical solar still consists of system made of either wood, galvanized iron sheet, cement ,etc and a glass of some thickness introduced in it with some inclination (the inclination takes from latitude of that place where solar still is situated .Again the system is being insulated by the silicon, glasswool, thermocol, etc such that the less heat extraction takes place in the system; the basin of solar still where water is collected painted black so as to absorb all the radiant energy reaching to the surface . now as the solar energy coming from the sky in the form of convection and radiation got trapped in between the glass and water ;so that the evaporation of water takes place and got converted into the steam , again as the steam comes

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under the surface of glass plate it got converted into small droplet of water by naturally flowing wind on the surface of glass plate and process of condensation took place. Therefore we get distilled water which may collect in some pot.

Fig.1 – Evacuated tube solar collector

Fig.2 – Solar still

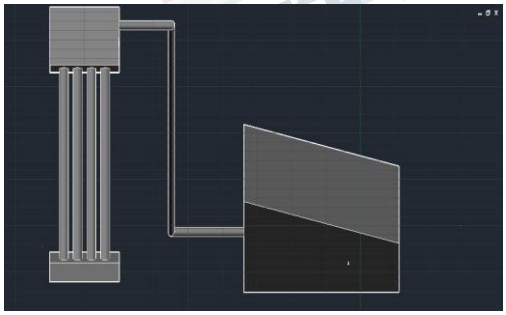

Fig.3 – Schematic diagram using AutoCAD

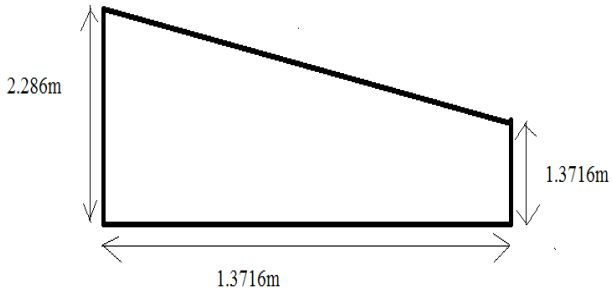

Fig.4 – Dimension of Solar Still

We performed an experiment in Birla Institute of Technology, Mesra Ranchi (latitude - 23°45´N and longitude 85°30´) at solar energy laboratory. We construct a solar still of area 1.25m². Large side is 2.286m and lower side is 1.3716m got inclination in which we incorporate a glass of thickness 0.004m. The whole device is painted black for maximum radiation absorption. Again the whole device is insulated with thermocol and plywood surrounds it. We have incorporated a fan in middle of the solar still. We put the already heated water from evacuated tube solar collector (no of tubes - 10, inclination -34°67´) to the solar distillation system so that it took less time to evaporate and we also incorporated a fan of 2400rpm in between the solar still (100 – 110 rpm in atmospheric air).

III. RESULT AND DISCUSSION

The experiments have been performed at solar energy laboratory at Birla Institute of Technology Mesra Ranchi (latitude - 23°45´N and longitude 85°30´). The observation tables are mention as follow.

1. Evacuated tube collector (without fan) April 24, 2017 Water depth (0.03m)

Observation table

Time (hr)	Radiation (w/m²)	Wind speed(km/hr)	Water collected(ml)
11.00AM-12.00PM	1172	11	490
(12.00-1.00) PM	1180	15	450

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Vol 2, Issue 5, May 2017

(1.00-2.00) PM	1075	19	470
(2.00-3.00) PM	600	18	360
(3.00-4.00) PM	685	13	210
(4.00-5.00) PM	245	14	150

Water temp(°C)	Relative humidity (%)	Pressure (Kpa)	Glass Temp(°C)	U.V Index
50	16	101.30	34	12
50	20	101.20	35	12
41	11	100.6	40	10
54	11	100.5	40	7
48	17	100.9	37	6
47	17	100.90	35	4

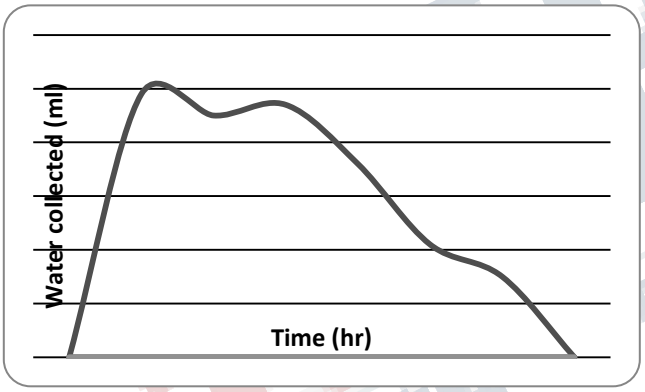

Fig.5 – Time (hr) Vs Water collected (ml) graph

From the above data it clearly indicates that as the radiation decreases the production rate of distilled water decreases as from radiation 1172 w/m² to 245 w/m² gives distillation 490ml to 150ml. In this approach we can say that as at day day time as the solar radiation was high it effects the solar still so that the glass of the sill absorbs high energy and already heated water from the evacuated tube took less time to evaporate and we got 490ml of water

2. Evacuated tube collector (with fan) April 28, 2017 water depth (0.03 m)

Observation table

Time (hr)	Radiation (w/m²)	Wind speed(km/hr)	Water collected(ml)
11.00AM-12.00PM	1090	13	530
(12.00-1.00) PM	1088	22	630
(1.00-2.00) PM	916	22	380
(2.00-3.00) PM	695	19	530
(3.00-4.00) PM	396	13	400
(4.00-5.00) PM	325	15	230

Water temp(°C)	Relative humidity (%)	Pressure (Kpa)	Glass Temp(°C)	U.V Index
48	31	100.90	37	13
41	22	100.90	40	12
49	16	107.90	35	10
51	21	100.60	35	7
45	22	100.50	40	4
37	19	100.50	34	1

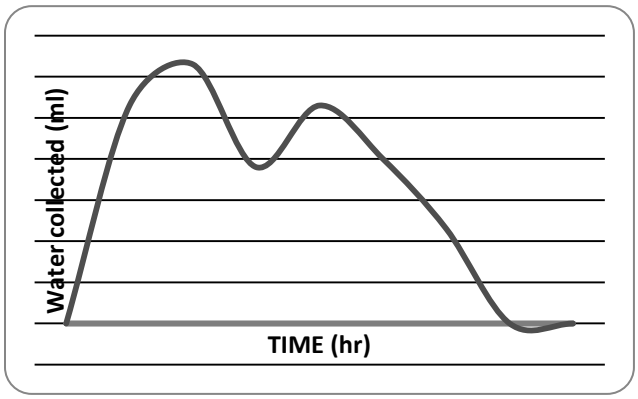

Fig.6- Time (hr) Vs Water collected (ml) graph.

ISSN (Online) 2456-1290
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From the above data as radiation were 1090 w/m² and the fan with rotation speed 100-110 rpm (atmospheric air) was rotating inside the solar still makes evaporation of water because of solar radiation and constant heat trapping by the air in between the glass and water. As the water was revolving through fan it produces the churning effect ,which increases the evaporation rate of water wind speed 13 km/hr and relative humidity (31%)indicates it effected the condensation so that and good amount of distilled water produces from good evaporation.

3. Evacuated tube collector (without fan) water April 26, 2017 water depth (0.03m)

Time (hr)	Radiation (w/m²)	Wind speed(km/hr)	Water collected(ml)
11.00AM-12.00PM	1199	11	450
(12.00-1.00) PM	1160	11	370
(1.00-2.00) PM	960	13	330
(2.00-3.00) PM	843	13	300
(3.00-4.00) PM	586	13	170
(4.00-5.00) PM	200	11	150

Water temp(°C)	Relative humidity (%)	Pressure (Kpa)	Glass Temp(°C)	U.V Index
46	19	101.10	39	11
56	17	101.10	38	11
52	14	100.00	38	9
46	14	100.90	36	9
46	13	100.90	42	7
47	19	100.80	38	4

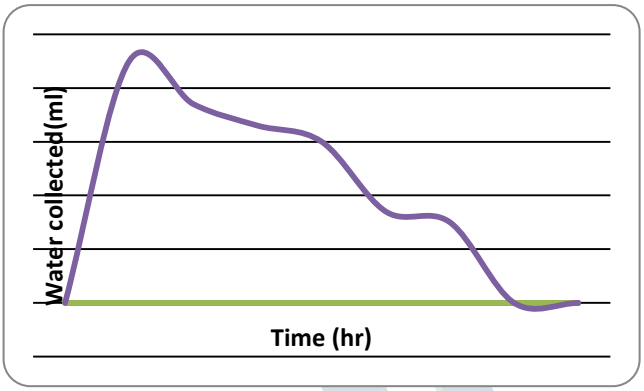

Fig.7- Time (hr) Vs Water collected (ml) graph.

The graph clearly indicates that the radiation were highest in first hour so that we get 450ml of water again as the radiation decreases the distilled water production rate decreases . Production rate of distilled water affected by the wind speed and the humidity because as the wind speed remains constant for first two hour and the radiation goes decreases means we were getting less energy to evaporate the water, although air which is trapped in between the glass and the water works as energy absorbing system which get radiation energy from the sun and get heated again they cools up slowly so that the evaporation rate enhances.

4. Evacuated Tube Collector (with fan) April 26, 2017 Water depth (0.03m)

Time (hr)	Radiation (w/m²)	Wind speed(km/hr)	Water collected(ml)
11.00AM-12.00PM	1012	11	520
(12.00-1.00) PM	1140	15	640
(1.00-2.00) PM	1010	15	350
(2.00-3.00) PM	873	15	564
(3.00-4.00) PM	706	17	410
(4.00-5.00) PM	435	15	200

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Water temp(°C)	Relative humidity (%)	Pressure (Kpa)	Glass Temp(°C)	U.V Index
56	31	100.90	31	12
58	20	100.90	40	13
59	14	100.80	40	12
54	11	100.59	41	10
55	17	100.54	41	9
53	11	99.86	39	7

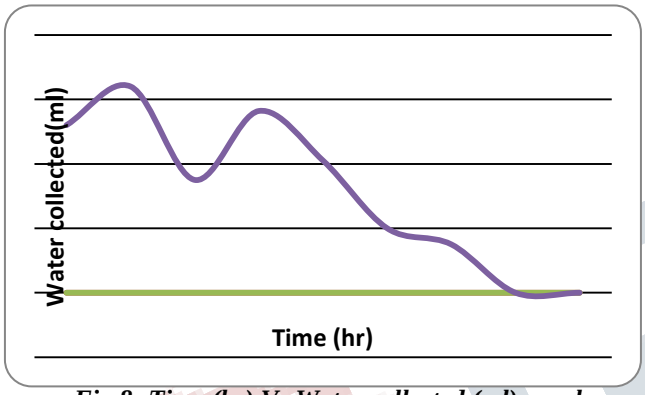

Fig.8- Time (hr) Vs Water collected (ml) graph

radiation were 1012 w/m² and the fan with rotation speed 100-110 rpm (atmospheric air) was rotating inside the solar still makes evaporation of water because of solar radiation and constant heat trapping by the air in between the glass and water. As the water was revolving through fan it produces the churning effect ,which increases the evaporation rate of water wind speed 11 km/hr and relative humidity (31%)indicates it effected the condensation so that and good amount of distilled water produces from good evaporation.

IV. CONCLUSION

The radiation coming from sun in visible light (which is short wave ultraviolet 13 extreme) from data and from digital solarimeter we found (1090 w/m²) of radiation indicates that good amount of solar energy coming from sky to solar distillation system , heated the glass plate and temperature of glass plate (37°C) got transmitted from transparent glass and makes the air hot which is trapped in between the glass plate and already heated water from evacuated tube collector (48°C) took less time to evaporate , such that the temperature and vapor pressure increases successively, results in faster evaporation . This generates the water vapor and vapor comes under the glass plate the wind was blowing with 13km/hr i.e.

Natural convection took place on the surface of glass plate. The humidity is also closely related to evaporation ;the humidity the actual amount of water vapor present in atmospheric air to the maximum of water that air can hold at particular temperature . This indicates the relative humidity decreases as the temperature increases, now we can say the water which turned into vapor (increased vapor pressure) holds the water under the glass plate again as wind is flowing outside which results the vapor inside the solar still into small droplet of water by the process called condensation and the tiny droplet is distilled water, which is collected in some pot. From the respective experiment we come to conclude that the collection rate of distilled water with fan is 34.05% & 21% more than the percentage amount of distilled water collection without fan. This clearly shows that application of fan and evacuated tube solar collector enhances the water production rate of solar distillation system.

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