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EXPERIMENTAL INVESTIGATION TO IMPROVE THE PERFORMANCE OF SOLAR DISTILLATION

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Abstract

This paper describes methods to enhance solar efficiency by the quantity of transparent glasses on the top cover. The efficiency of the solar shape of the square pyramid is still more than the conventional single and double solar slope. The productivity of this would may increase if using different materials on the absorber plate like, black gravel and pebbles, and study the influence of these factors on the evaporation and condensation rate of water in the still by experimentally.

Keywords: square pyramid shape solar still, fully transparent glass, pebbles, black gravels.

1. Introduction

Water is very important for all living organisms. We couldn't even think world without water. Water is the heart of the earth. Each and every living organism exists based on the availability of water. But, nowadays the availability of water becomes less due to the industrial development. The water should have preserved for all living things. Solar distillation is a fairly simple treatment of the supply of water to saline (i.e. containing dissolved salts). Distillation is one of many techniques for water decontamination that can be hand-me-down and can use a heating source. A low-tech option is solar energy. Water is evaporated in this process; the vapour condenses as clean water using the sun's energy. Salts and other impurities are extracted by this process. There was still a large form of basin that was still could provide fresh water to a nitrate mining group using brackish feed water. The plant used wood bays that used logwood dye and alum to have darkened bottoms.

The distillation plant's total area was 4,700 square metres. This plant provided 4.9 kg of cleaned water per square metre of still surface or greater than 23,000 litres per day, on a typical summer day. The method of solar water distillation is also called "Solar Still". Solar Also is able to process seawater and even raw sewage successfully. Salts / mineral deposits (Na, Ca, As, Fe, Mn), Bacteria (E.coli, Cholera, Botulinus), Parasites (Na, Ca, As, Fe, Mn), TDS & Heavy Metals are extracted by solar still.

Hitesh N Panchal et.al [1, 6] Effect of varying glass cover thickness on performance of solar still: in a Winter Climate Conditions. In this research paper, investigation made to unearth the effect of different thicknesses glass cover on passive single-slope solar still. Pankaj K. Srivastava [2] presented Experimental and theoretical analysis of single sloped basin type solar still consisting of multiple low thermal inertia floating porous absorbers. The results indicate that on the modified still provide about 68% in clear day clear days, was nearly 35%. H.N. Singhet et al. [3, 7] A solar collector is a parabolic trough in which brine circulates as a thermal fluid. The steam is obtained directly from the circulating brine. The solar collector field can be connected to a condenser / preheater heat exchanger. However, the power ratio of the system will be lower. M.T Chaibiet et al. [4, 5] discussed on these technologies that are suitable for use in remote villages. Solar energy combined with distillation provides a promising prospect for meeting the basic needs of electricity and water in remote areas where water shortages are high, as connections to public power grids are cheap or impossible**.** Seshadri et al. [8-13] In addition, solar panels can be combined with a multi-stage flash or multi-effect distillation system to continue

evaporation of the remaining brine. Examined the impact of polymer Nano-composites coated with double hydroxide. Research into the mechanical characteristics of epoxy resin matrix bio-composites filled with jute fibre reinforced coconut shell particles was carried out experimentally [14-16]. In the literature review, the use of granite powder with coconut shell ash and epoxy resin composites appears to be rare. It has been attempted to prepare and evaluate the flexural characteristics of epoxy resin composites reinforced with granite powder particles and coconut shell powder [17-23].

2. Experimental Setup

Solar distillation is a method for the processing of drinking water from salt water that is ecofriendly. The aim of the study is to improve efficiency. By adjusting the top glass cover plate of the still, solar still and contrasting the output factors with double slope and single slope still solar. For achieve this I changed the shape of the cover plate of the still to four sided transparent glass cover. Then we can increase the collection of solar flux to the still.

In this project, solar still with four sided slope glass cover is introduced. It will increase the effect of solar radiation to high level in the solar still. We know that the single slope and double slope still are there, but the productivity of these two solar still not much good. The square shaped fully transparent glass cover should improve the performance of solar still by increase the number of slope top glass cover to four. Then it can absorb the solar radiation from four sides of the still.

The solar still consists of flat absorber plate, thermocoal, wood, water channel, and four transparent glasses. The absorber plate is aluminium of thickness 2mm with $1m^2$ base area. The absorber plate is inserted into the square shape wooden box of area $1.74m^2$. A layer of thermocoal is placed under the absorber plate for to prevent the heat transfer to the surroundings. The thickness of the thermocoal is 16mm. The height of the wooden box is about 20cm. The wooden box is covered with four sided slope glass cover. The thickness of the glass is 4mm and transmissivity of 0.7. A water channel is located just below the glass cover for to collect the condensed water from the cover plate. The four glasses are mounted an inclination of 150slope. The water inside basin will be heated up by using the solar radiation from the sun. Then, the bond between the water molecules will be dissociated and become evaporated. The vapour from the process of evaporation will rise and touches on the top glass cover. The vapour temperature inside the still increased, it helps for the further evaporation of water inside the still. After some time vapour will be condensed and stored on the glass cover, the condensed water will flow through the glass top cover due to gravity and it collected in the water channel just below the glass cover. The water channel is made with PVC pipe of 4cm dia. The distilled water is collected in a container, which is taken through an outlet with dia.4mm.

The experiments were carried out by flat plate, flat plate with black gravels and flat plate with black pebbles, and investigate the performance of still.

Fig 1: Square pyramid solar still

3. Experimental Procedures

The experiment was done by some ordered procedures, Pour the tap water into the water basin up to 1cm depth, then close the water basin with square pyramid glass top cover and close every air gap, ensure there is no air gap on the still. Allow the absorber plate and water to become hot under sun light then evaporation of water will have occurred, and take the readings such as, solar flux, ambient temperature, glass temperature, plate temperature, water temperature and water production at each and every one hour. These procedures are following for flat plate with black gravels and black pebbles.

4. Result and Discussion

The experiment was conducted in four sided top glass cover solar still on 9-1-2017 (with flat plate alone), 11-1-2017 (black gravel) and 12-1-2017 (black pebbles) from 10.30am to 4.30pm. The readings were taken at every one-hour regular interval of time. The water was also collected from the basin and measured the hourly production of water at every one hour. The readings which were took from the stills, glass temperature on four sides, vapour temperature inside the still, absorber plate temperature, and water temperature, and also noted the intensity of solar radiation. The readings were noted from the still were tabulated in the table below.

Table 1: Experimental readings on flat plate (9-1-2017)

Sl.No	Time	Solar flux (W/m^2)	Ambient Temp. (^oC)	Glass Temperature (^oC)				Tv (^oC)	Tab (^oC)	Twater (^oC)	Water Production (ml)	
				Tg1	Tg2	Tg3	Tg4				Water Collected	Cumulative Collection
1	11.00	1032	34	34.1	36	37	36.5	48	45	50	170	170
2	12.00	1062	35	42	41.4	38.4	40.3	50	51.5	54.5	250	420
3	13.00	1088	37	44.9	44.2	43.8	44.2	60.5	64.7	64.8	690	1110
4	14.00	975	34.2	37.1	37	38.8	38	56.2	55.5	62.5	600	1710
5	15.00	735	32.7	37.2	39.6	39.9	39.1	53	49	53.5	420	2130
6	16.00	700	32	37	36	36.5	37.3	50	47	49.7	170	2300

Table 2: Experimental readings with black gravels (11-1-2017)

Sl.No	Time	Solar flux (W/m^2)	Ambient Temp. (^oC)	Glass Temperature (^oC)				Tv (^oC)	Tab (^oC)	Twater (^oC)	Water Production (ml)	
				Tg1	Tg2	Tg3	Tg4				Water Collected	Cumulative Collection
1	11.00	890	31.5	31.5	35.1	36.5	35.2	42	43.1	43.3	180	180
2	12.00	1036	33.5	36.5	39.2	41.5	42.4	59.3	54.5	59.6	260	440
3	13.00	1036	36.9	47.9	47.9	47.6	44	58.6	62	61.2	700	1140
4	14.00	1030	36	45.9	46.9	47	43.8	59.4	60	60.9	680	1820
5	15.00	820	33.8	42.1	43	43.2	42.5	55.9	56	56.7	480	2300
6	16.00	675	32	37.2	36	38	37.4	53.1	53	53.6	240	2540

Table 3: Experimental readings with black pebbles (12-1-2017)

Sl.No	Time	Solar flux (W/m^2)	Ambient Temp. (^oC)	Glass Temperature (^oC)				Tv (^oC)	Tab (^oC)	Twater (^oC)	Water Production	
				Tg1	Tg2	Tg3	Tg4				Water Collected	Cumulative Collection
1	11.00	1070	33.2	42.3	44.3	44.7	43.4	50.3	53.8	54.2	210	210
2	12.00	1100	33.8	47.8	48.1	47.9	47.8	56.2	60	60.2	450	660
3	13.00	1120	37.2	49.9	50	50.7	52.2	63	62.1	62.6	710	1370
4	14.00	1069	35.4	49.8	48.9	48.5	48.1	60	61	60.7	730	2100
5	15.00	985	33.6	41.1	42.6	43.2	42.1	52	53.2	53	480	2580
6	16.00	890	33	39.7	41.5	41.7	40.4	52	53.4	55	320	2900

The critical parameter for growing the productivity of the still is the solar flux. To between 12.00 and 1.00 pm, the maximum amount of solar flux is available. The vapour temperature and water temperature is also depending on the solar flux at each time, so the maximum vapour temperature and water temperature achieve at around 12.00 and 1.00 pm. The water temperature and plate temperature is almost equal inside the still. The maximum amount of water collected from the still when added the black pebbles along with flat plate that is 2900ml/day. The all experiments were carried out at sunny days. The evaporation rate was increased due to increase the surface area by using black gavels and black pebbles. Due to highest degree of black coating on pebbles the water production in this arrangement is greater than the arrangement with black gravels.

The hourly production of water from these arrangements is shown in fig 3. The greater water production is available from the still if are using the black painted pebbles along with flat plate. The fig 2 represents the variation of vapour temperature for each condition.

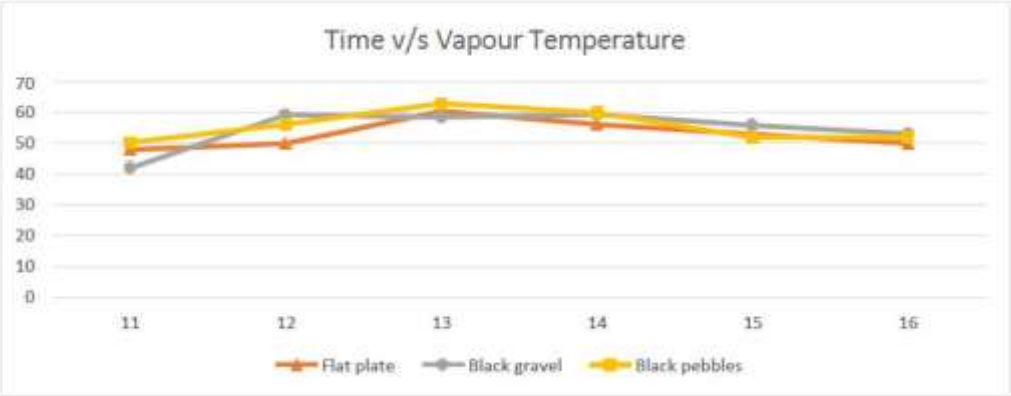

Fig 2: Time v/s Vapour temperature

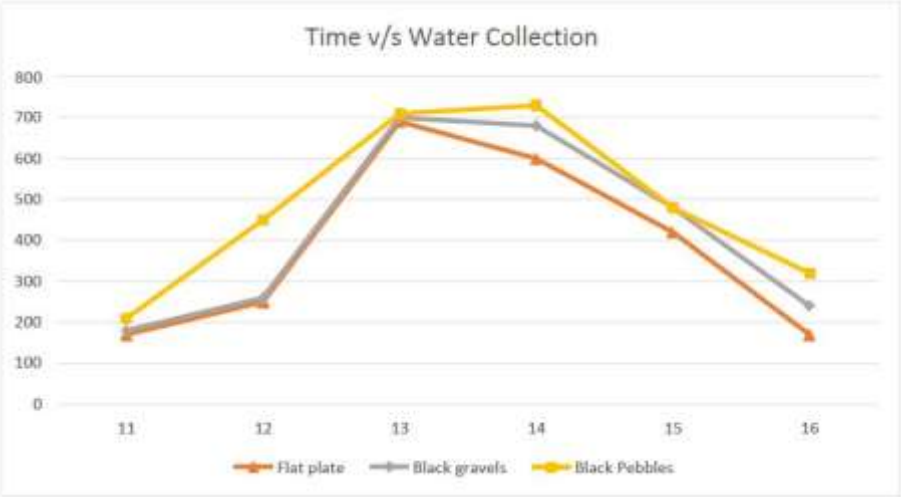

Fig 3: Time v/s Water collection

5. Conclusion

The experiment was conducted by introducing square pyramid shape glass top cover with flat plate, flat plate with black gravels and flat plate with black pebbles. At the end of the day, the water obtained was greater than the water collected from the double slope solar still and single slope solar still for the same surface area per day. The water collected from the still if are using flat plate alone is 2300ml/day. The collection of water was increased to 2540ml/day when add black gavels along with flat plate, and it again increased to 2900 ml/day with black colored pebbles. From this we can conclude that the evaporation rate will improve when increase the surface area of the absorber plate. The evaporation rate also depends on the degree of black colour on the plate and stones. The highest evaporation rate is achieved when using the black coloured pebbles. Besides the top cover of the still is fully transparent so it will absorb more amount of solar flux, so the heat inside the still would increase and thereby increase the evaporation rate and water productivity. The slope of glass cover is 15°, so the solar radiation which enters into the still is higher. Due to the four sided surface the condensation rate also increased.

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