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Performance Analysis of Solar Distillation with Reflector

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ABSTRACT:

There will be almost no water left on the earth that is safe to drink without purification after 20-25 years. This is a seemingly bold statement, but it is unfortunately true. Only 1% of Earth's water is in a fresh, liquid state, and nearly all of this is polluted by both diseases and toxic chemicals. For this reason, purification of water supplies is extremely important. Keeping these things in mind, a model is devised which will convert the dirty/saline water into pure/potable water using the solar energy (i.e. renewable source of energy). The basic modes of the heat transfer involved are radiation, convection and conduction. The results are obtained by evaporation of the dirty/saline water and fetching it out as pure/drinkable water. The designed model produces 0.6 liters of pure water from 4 liters of dirty water during six hours. The efficiency of plant is 38.37%.

LITERATURE SURVEY:

Prof. Minesh APatel have devised a model which is single slope solar still. The water evaporates only to condense on the underside of the glass. When water evaporates, only the water vapor rises, leaving contaminants behind the slope of the glass directs the condensate to a collection trough, which in turn delivers the water to the collection bottle. Thermal Modeling of single slope basin type solar still is prepared analytically for the evaluation of its performance characteristics by applying energy balance equations. Half hour interval is taken for readings and due to readings different graphs are plotted. Professor Alpesh arjun have devised a model which will convert the dirty/saline water into pure/potable water using the renewable source of energy (i.e. solar energy). The basic modes of the heat transfer involved are radiation, convection and conduction. The results are obtained by evaporation of the dirty/saline water and fetching it out as pure/drinkable water. The designed model produces 1.5 liters of pure water from 14 liters of dirty water during six hours . The efficiency of plant is 54.37%. The TDS(Total Dissolved Solids) in the pure water is 81ppm. professors S. H. Sengar designed a single basin wick type solar desalination corrugated galvanized iron sheet of area 1 m2 as an absorber in between the wick strip for obtaining maximum temperature inside the distiller. The cost of the system was calculated. The efficiency of the SBWSD was 47.14% in winter and 56.29% in summer.

CONSTRUCTION OF SOLAR STILL:

The base of the solar still is made of wooden box . This box is embedded into another box of wood shown in figure. Here length L= 60 cm, Breath B= 40cm, Height H= 30 cm. and at opposite side = 13 cm, Angle Θ = 30. The channel is fixed such that the water slipping on the surface of the glass will fall in this channel under the effect of gravity. A frame of fiber stick is fixed with the wooden box so that glass can rest on it. This completes the construction of the model. The holes for the inlet of water, outlet of brackish water and outlet of pure water is made as per the convenience. We have made the outlet of brackish water at right bottom of the model (seeing from front of the model), outlet of the pure water at the end of the channel and inlet at the right wall above the outlet.

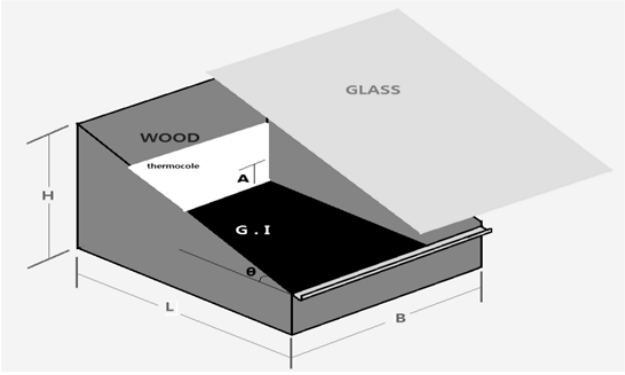

Fig 1.1: Proposed Model of Solar Distillation System

PERFORMANCE ANALYSIS OF SBASD:

Experiment conducted with and without aluminum sheet at different water levels means at 8lts and 4 lts,

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due to this the heating surface area of the plant increases and the efficiency of the plant will increases. Hourly distilled water as well as cumulative distillation rate was studied in this experiment.In performance analysis we can study how to increase the solar radiation by using different sizes of reflector, in this aluminum sheet is used as a reflector and different quantities of feed water is used in this experiment.

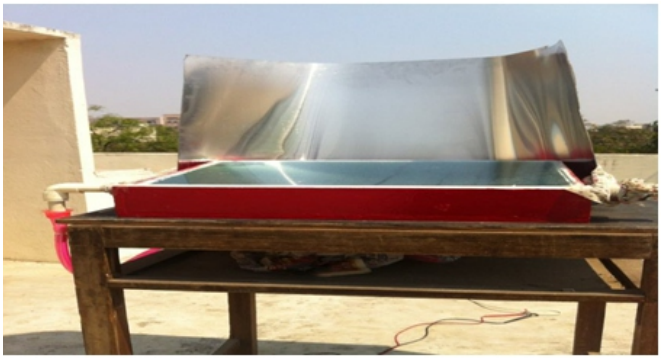

Fig1.2: solar still with large aluminum sheet

In above figure solar still is constructed with reflector and the experiment is conducted with different quantities of feed water (8liters and 4 liters). It is used to increase the solar radiation by absorbing more solar heat and distillate is collected for every 30 min and experiment is conducted from 10 am to 3.30 pm. Radiation and temperature reading also be measured by using anemometer and pyaranometre. The efficiency of the plant is less due the shaded area of aluminum sheet size is large ,so we can move to required size of aluminum sheet then we can achieve good results from the plant. Compare to without reflector we got more efficiency.

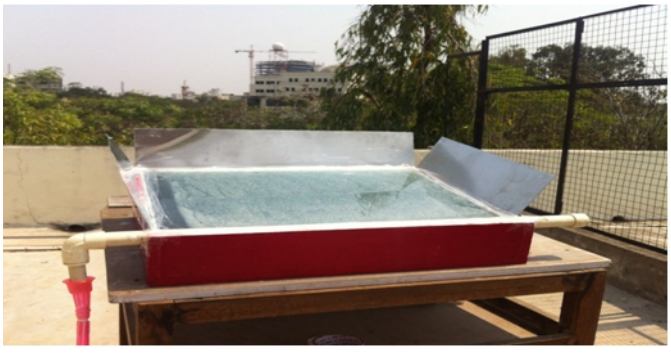

fig.1.3: solar still with required size of aluminum sheet

In above figure solar still is constructed with reflector and the experiment is conducted with different Quantities of feed water (8liters and 4 liters). It is used to increase the solar radiation by absorbing more solar heat and distillate is collected for every 30 min and experiment is conducted from 10 am to 3.30 pm. Radiation and temperature reading also be measured by using anemometer and pyaranometre. The efficiency of the plant is more because we are using required size (120 mm) of aluminum sheet so we can achieve good results from the plant.

EXPERMENTAL CALCULATIONS:

Experiment is conducted with and without aluminum sheet from December to April 2013. Experiment performed from 10:00Am to 3:30 Pm. At different water levels means at 8 liters and 4liters, due to this the heating surface area of the plant increases and the efficiency of the plant will increases. Hourly distilled water as well as cumulative distillation rate was studied in this experiment. And experiment conducted with saline water

EFFICIENCY OF SOLAR STILL :

The efficiency of a still can be calculated by the following equation:

η = Water output * Latent heat of evaporation of water/ Daily solar radiation

Daily Efficiency Values with large reflector (aluminum sheet) for 27th of Feb, 17th of March and 10th of April.

Date	Efficiency (%)
27.02.2013	20.67
17.03.2013	26.82
10.04.2013	30.25

Daily Efficiency Values with reflector (aluminum sheet) for 3rd of March, 27th of March and 16th of April.

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Date	Efficiency (%)
O3.03.2013	24.67
27.03.2013	30.82
16.04.2013	38.25

RESULT AND ANALYSIS:

Experiment performed from 10:00AM to 3:30 PM . Experiment conducted with and without aluminum sheet at different water levels means at 8 liters and 4 liters, due to this the heating surface area of the plant increases and the efficiency of the plant will increases. Hourly distilled water as well as cumulative distillation rate was studied in this experiment. In this work, a solar distillation in a single basin is studied theoretically and experimentally.

The aluminum reflector was assembled to the still and effect of the reflector on the still Productivity was examined.It is proposed to study the performance of solar Still at different configurations as listed below.

Case 1: solar distillation without reflector with 8 liters of saline water.

Case 2: solar distillation with large reflector (aluminum sheet) and with 8 liters of saline water.

Case 3: solar distillation with required size of reflector (aluminum sheet) and with 8 liters of saline water .

Case 4: solar distillation without reflector with 4 liters of saline water.

Case 5: solar distillation with large reflector (aluminum sheet) and with 4 liters of saline water.

Case 6: solar distillation with required size of reflector (aluminum sheet) and with 4 liters of saline water.

Experimental Result of Solar Still with 8 liters of feed water

Time	case 1				Case 2				Case 3			
	Ta (0C)	I (W/m2)	X(ml)	η	Ta (0C)	I(W/m2)	X(ml)	η	Ta (0C)	I(W/m2	X(ml)	η
10:30	32	522			31	522.1			30	429		
11:00	33	398	15	23	33	614.8	180	25	35	537	210	25
11:30	35	661			35	661.15			36	614		
12:00	36	692	220	24	36	692.05	220	25	37	630	300	28
12:30	37	646			36	692.05			38	661		
1:00	37	568	280	25	37	645.7	300	26	39	614	390	28
1:30	38	491			38	491.2			38	491		
2:00	38	414	400	25	37	645.7	380	25	37	460	460	30
2:30	36	3989			36	692.05			36	429		
3:00	34	306	400	26	35	305.8	450	27	33	429	520	31
3:30	33	398	440	25	34	298.7	500	26	33	398	580	32

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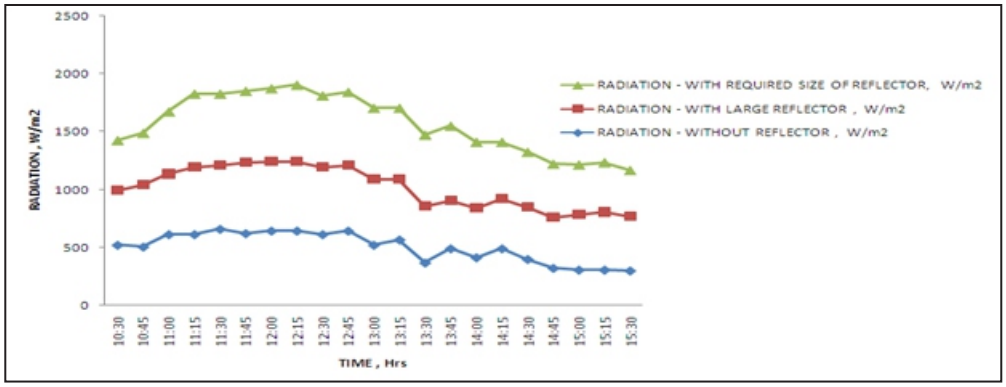
According to the observation as shown above the maximum temperature was 39 oc, with this temperature the distillate collected from the solar still with large reflector is 580 ml. we are using required size of a reflector (aluminum sheet) to increase performance of the solar still, due to this the distillate collected is increased and using this data we can calculate efficiency and solar radiation of a solar still. Observations as shown above we calculated solar radiation and efficiency of the still with 8 liters of saline water. By using reflector the performance is improved and maximum efficiency and solar radiation achieved are 32% and 753.85 W/m2 respectively.

Experimental Result of Solar Still with 4 liters of feed water

Time	case 4				Case 5				Case 6			
	Ta (0C)	I(W/m2)	X(ml)	η	Ta (0C)	I(W/m2)	X(ml)	η	Ta (0C)	I(W/m2)	X(ml)	η
10:30	31	522.1			31	522.1			30	520.2		
11:00	32	614.8	160	25	33	614.8	200	26	32	614.8	250	25
11:30	35	661.15			35	661.15			36	692.05		
12:00	36	692.05	240	26	36	692.05	280	27	36	692.05	320	28
12:30	37	645.7			36	692.05			37	645.7		
1:00	37	568.45	320	26	37	645.7	350	26	38	491.2	410	30
1:30	38	491.2			38	491.2			38	491.2		
2:00	38	413.95	400	27	37	645.7	430	30	37	413.95	520	38
2:30	36	3988.5			36	692.05			36	692.05		
3:00	35	305.8	440	27	35	305.8	510	28	35	305.8	600	39
3:30	34	298.7	480	28	34	298.7	570	30	34	298.7	650	39

According to the observation as shown above the maximum temperature was 38 oc, with this temperature the distillate collected from the solar still with large reflector is 650 ml. we are using required size of a reflector (aluminum sheet) to increase performance of the solar still, due to this the distillate collected is increased and using this data we can calculate efficiency and solar radiation of a solar still. Observations as shown above we calculated solar radiation and efficiency of the still with 4 liters of saline water. By using reflector the performance is improved and maximum efficiency and solar radiation achieved are 39% and 753.85 W/m2 respectively.

GRAPHS



SOLAR RADIATION Vs TIME

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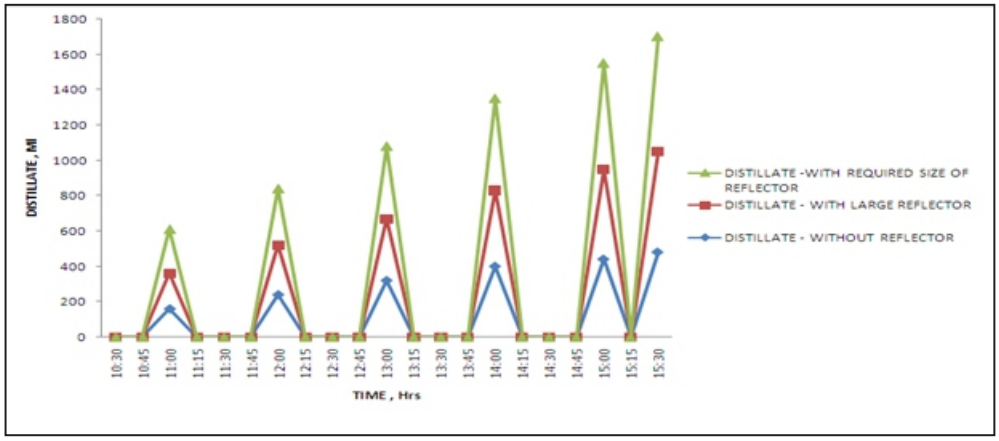
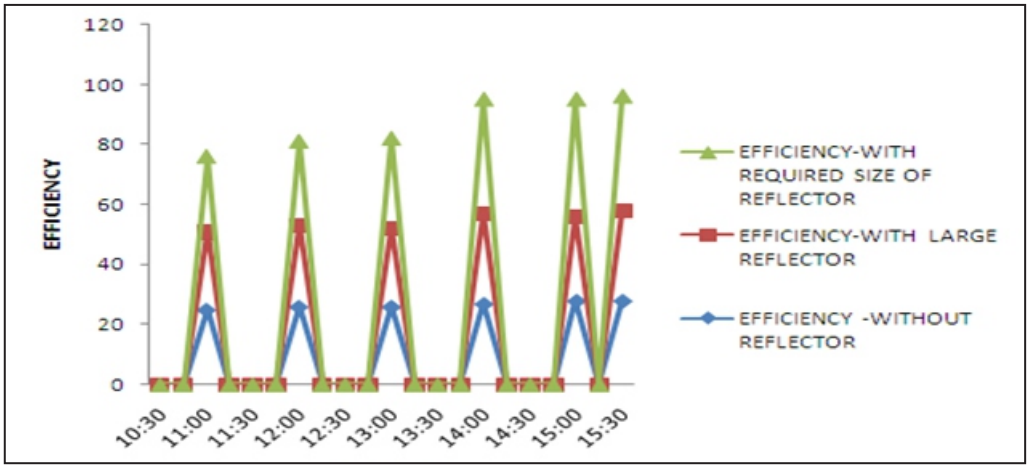


DISTILLATE Vs TIME WITH 8 LITERS OF FEED WATER



EFFICIENCY Vs TIME WITH 8 LITERS OF FEED WATER

CONCLUSION:

According to experiments, following points may be concluded:

» The important factor which affects productivity of the solar still is solar radiation. When higher solar insulation is received the productivity of the solar still increase.

» Efficiency of the solar still has a little alteration with increasing of ambient air temperature.

» When the temperature difference between the interface temperature and glass cover temperature increase, amount of distilled water from the still raise.

» The reflector which is used to concentrate solar radiation into the still increased solar radiation value

» The maximum amount of distillate obtained from the still on 09.04.2013 is 6oo ml/m2hr.

» The important variables on solar desalination are solar radiation, ambient air, inclination of glass cover .

» The important factor to increase efficiency is the prevention of the leakage of the moist air from the still.

» The evaporation is maximum in the period of 11:30 am to 1:30 pm

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