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PARAMETRIC FACTORS AFFECTING PERFORMANCE IMPROVEMENT OF A SOLAR STILL

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ABSTRACT

With the increase of population, the task of providing adequate supplies of fresh water may indeed become the most serious problem facing the world. The solar still creates a new path to obtain fresh water using solar energy. Distillation is one of many processes that can be used for water purification. A "solar still" is a device by which distilled or portable water can be produced from saline water, such as seawater or brackish water. The present paper describes about designing and fabrication of a single basin solar still. Further experimentation was done on the solar still. "Parametric factors" such as water depth, solar radiation, glass cover inclination, temperature of glass cover, temperature of water basin were studied. A specific yield of pure water was obtained. The efficiency of the solar still is noted.

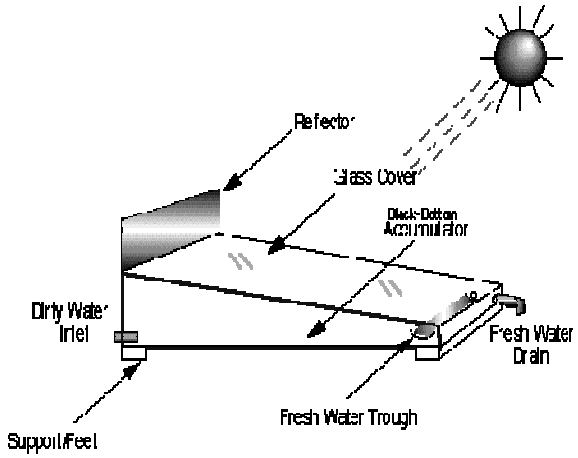
KEYWORDS: Still, Parametric, Water Depth

Source of fresh water must be found and the most likely sources are the great oceans and that can be desalinated by various methods. The solar still create a new path to obtain fresh water using solar energy. Distillation is one of many processes that can be used for water purification. Solar radiation can be the source of heat energy.

A solar still is a device by which distilled or portable water can be produced from saline water, such as seawater brackish water. Solar still are normally used to provide a small scale of portable water needed in remote isolated location, where there is plenty of solar energy source of saline water are available.

There is an urgent need of clean, pure drinkable water in many countries. Often water sources are brackish and or contain harmful bacteria and therefore cannot be used for drinking. In addition, there are many coastal locations where seawater is abundant but potable water is not available. Pure water is also needful in some industries, hospitals and schools.. In this process, water is evaporated and thus separating water vapour from dissolved substances, and is then condensed as pure water bottle. Water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region. Water scarcity can be a result of two mechanisms: physical (absolute) water scarcity and economic water scarcity, where physical water scarcity is a result of inadequate natural water resources to supply a region's demand, and economic water scarcity is a result of poor management of the sufficient available water resources. A conventional basin type solar still is simply an air tight basin that contains a shallow layer of saline water, a sloped top cover of a transparent material usually glass to solar radiation and side metal frame walls. First of all, it was important to evaluate the performance of the traditional solar still design as a reference. This helps to measure the improvements due to the new modifications. The exterior surfaces of the still were painted black to improve absorption of the sun's rays. Water was poured into the still to partially fill the basin. The glass cover allows the solar radiation to pass into the still, which was mostly absorbed by the black basin. The water begins to heat up and the moisture content of the air trapped between the water surface and the glass cover increases. The basin also radiates energy in the infra-red region which was reflected back into the still by the glass cover, trapping the solar energy inside the still. The heated water vapor evaporates from the basin and condenses on the inside of the glass cover. Condensed water trickles down the inclined glass cover to an interior collection trough and out to a storage bottle.

Single Basin Solar Still



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MATERIALS AND METHODS

Parametric Factors

It is also proposed to study the different Parameters or Parametric factors that include Water depth, Solar radiation, Glass cover inclination, Temperature of water basin, Temperature of the glass-related with performance of a Solar Still.

Water Depth: 2cm water depth is best for good performance.(5.2L of input water). Solar Radiation: High intensity radiation improves the efficiency. Glass Cover inclination: A normal 10-20^0 inclination is suitable for best output, depending on the latitude and longitude of the place. Temperature of Glass Cover & Water basin: High water basin temperature and low glass cover temperature increases the efficiency of the system and also the yield.

Specifications

Glass cover: Thickness-3mm , Length=55cm, Breadth=55cm. Inclination-10^{0}basedon Latitude=11^{0}and Longitude 77^0 of Thrikkakara, Cochin Basin Dimensions: Length=55cm, Breadth=55cm,,Height=10cm,4cm ,Material of basin: Galvanized Iron(GI)sheet -22 gauge,1mm thickness, 3×3feet

Assembling and Manufacture

Fabrication of the whole unit is pretty straight forward and involves metal cutting, welding, glass cutting, sealing, painting and drilling. All these processes can be done at any local workshop using simple machines – lathe, drill, welding, milling etc.

The steps in the process of assembling are outlined as follows:

The outer box basin will be fabricated first, Pure water channel is made. The holes are provided for

a. Collecting distilled water.

b. Transporting saline water.

4. The whole system is sealed using sealant to prevent the air from leaking in from the atmosphere.

Fabricated Solar Still

Cost Analysis

Total cost of GI Basin = Rs 800,Cost of asta black paint = Rs 100 ,Cost of glass = Rs 220 ,Cost of accessories = Rs. 150 ,Cost of labour and machining = Rs 1000

Total Cost of the Project=Rs 2270

Measuring Instruments used

Radiation Meter, Digital Themometer, Anemometer,

Experimentation Procedure

Place the system under the sun in morning. and connect all the meters.Then Fill water in the basin up to a appropriate level. Measure the solar radiation and wind speed at different times. Measure the Atmospheric air temperature, Glass cover temperature, Basin water temperature. Note the distilled amount after every 1 hour. Work the still on a full day-24 hours. Note the distilled water in the beaker after 1 full day.

RESULTS

Table 1: Observations-Day 1: (2cm depth)

Sl. N.	Time	Radiation I(W/m^2) Obtained value	Glass cover temp T_g(^{0}C)	Basin water temperature T_w(^{0}C)	Atmospheric air temp T_a(^{0}C)	Wind speed (m/sec)	Distillate Amount-Yield (mL)
1	8.30am	527					
2	9.30am	673.5	0.2	54.8	28.2	52.8	40
3	10.30am	816	0.6	56.9	29.5	54.7	100
4	11.30am	835	0.2	59.6	31.7	57.1	170
5	12.30pm	875	0.4	62.2	34.8	59.2	260
6	1.30pm	814.5	1.0	59	33.7	56.2	340
7	2.30pm	735	0.5	54.1	32.3	51.6	390
8	3.30pm	651.75	0.3	50.3	31.7	49.1	430
9	4.30pm	295.5	1.2	45.5	29.8	43.5	450
10	5.30pm	147.5	0.7	40.8	27.7	38.5	460
11	8.30am	565.5	0.4	48.3	30.8	45.7	720

Table 2: Observations-Day 2: (3cm depth)

Sl. No.	Time	Radiation I(W/m$^{2)-}$ Obtained value	Wind speed m/sec	Water basin temperature T_w(^{0}C)	Atmospheric air temp T_a(^{0}C)	Glass cover temp T_g(^{0}C)	Distillate amount Yield(mL)
1	8.30am	418.5					
2	9.30am	603	50.6	51.7	28.4	0.6	50
3	10.30am	723	52.7	53.9	29.1	0.1	100
4	11.30am	735	56.4	58.2	29.8	0.8	160
5	12.30pm	891	58.7	60.7	30.6	0.4	230
6	1.30pm	663	55.3	57.0	31.5	0.3	290
7	2.30pm	508.8	51.2	52.8	33.9	0.2	340
8	3.30pm	392.25	49.3	50.8	33.2	0.5	380
9	4.30pm	225	42.5	43.8	31.8	0.2	410
10	5.30pm	141	36.5	37.5	29.2	0.8	430
11	8.30am	432	44.8	46.2	26.5	0.1	520

Table 3: Observations-Day 3: (2.5cm depth)

Sl. No.	Time	Radiation I(W/m$^{2)-}$Obtained value	Wind speed m/sec	Water basin temperature T_w(^{0}C)	Atmospheric air temp T_a(^{0}C)	Glass cover temp T_g(^{0}C)	Distillate amount Yield(mL)
1	8.30am	538					
2	9.30am	665	52.1	53.7	28.3	0.6	50
3	10.30am	801	54.5	56.6	28.2	0.4	100
4	11.30am	811	56.4	58.8	31.2	0.6	160
5	12.30pm	985	57.8	60.3	32.8	0.2	230
6	1.30pm	792	55.3	57.6	31.7	1.0	320
7	2.30pm	807	49.0	51.2	30.9	0.8	360
8	3.30pm	545	47.5	49.5	29.5	0.5	400
9	4.30pm	296	41.2	44.0	29.7	1.2	430
10	5.30pm	128	36.4	37.4	27.5	0.7	450
11	8.30am	589	44.7	46.3	29.6	0.5	600

Efficiency of a Solar Still

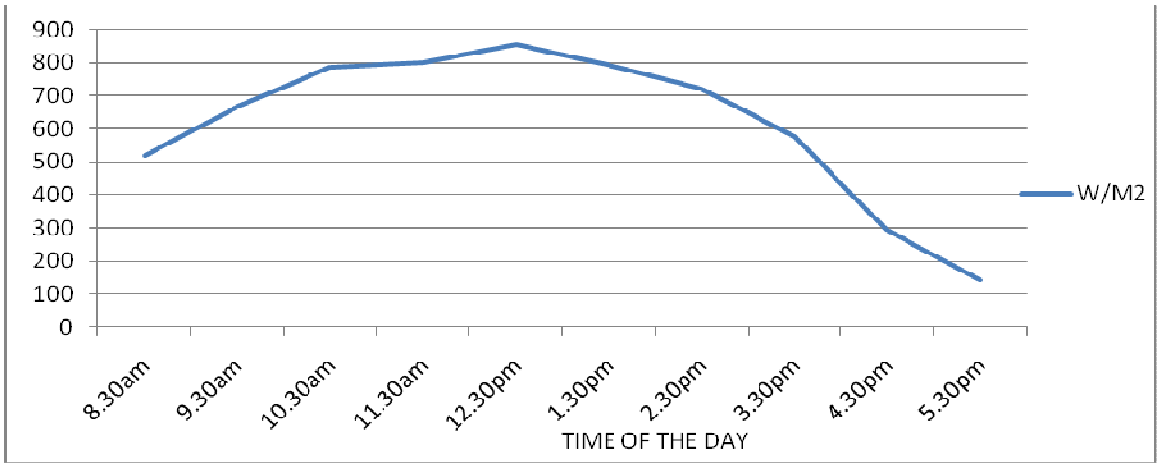
The Efficiency η of the still is obtained from the formula:

Efficiency η=[(Total Distilled amount-Yield÷t)× h_{fg}]÷∑I(t)×a, Yield(kg)=Volume×Density,

h_{fg} is the Latent heat of vapourisation of water obtained from the steam tables corresponding to average value of temperature of water basin(kJ/kg)., m=mass of water=total distilled amount=Volume× Density.(kg), a is Basin Linear area=0.3025m^2(0.55m-length×0.55m-breadth), ∑I(t) is Total Sum of Radiation intensities(W/m^2), t=Time in seconds for a full day operation(24hrs) Units:[(kg÷sec)×kJ/kg]÷(W/m^2×m^2)

Table 4: Experimental Calculations

Sl. No.	Time (sec)	Depth of water (cm)	Total Radiation(W/m^2)	Total Yield/Volume of water (mL)	Basin Area (m^2)	Temperature water basin (^{0}C)	Enthalpy (kJ/kg)	Efficiency (%)
1	3600×24 =86400	2	6936	3360	0.3025	54.35	2373.1	43.94
2	86400	3	6958	2920	0.3025	51.82	2378.0	38.17
3	86400	2.5	6955	3100	0.3025	52.12	2378.1	40.55



Graph: Radiation vs Time of the Day 1

DISCUSSION

Distillation is a method where water is removed from the contaminations rather than to remove contaminants from the water. Solar energy is a promising source to achieve this. The Solar distillation involves zero maintenance cost and no energy costs as it involves only solar energy which is free of cost.

Distillation is one of many processes available for water purification. is a method where water is removed from the contaminations.A Solar Still is fabricated and experimentation is conducted and based on the analysis it was found that the highest yield obtained is 720mL.The average efficiency of the Solar Still obtained is 40.88%

Parametric Factors that affect the Performance of The Solar Still are Solar Radiation, Temperature of Water Basin, Water depth (lower for greater performance).

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