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Solar Earth Water Still for Highly Wet Ground

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Abstract

The simulated performance of solar earth water still, suitable for very wet ground like beaches or swamps has been investigated. The still is essentially a single slope FRP still with a number of large holes in the bottom. It is seen that the daily distillate output of this still is almost the same as that of the conventional single slope FRP still viz 3.06 liters/ day at Raipur, India in March.

Keywords: Solar distillation; Earth water still

Introduction

The solar earth water still is a device to produce distilled water, by condensation of moisture in the ground. It is essentially a conventional basin solar still, without a bottom, placed directly on the ground. The moisture on the surface of the ground gets evaporated at the high surface temperature, attained by the incidence of sunlight; the moisture is replaced by diffusion from below the surface and the surrounding soil. The pioneering experiments on the solar earth water stills were conducted by Kobayashi in the suburbs of Tokyo, Mt. Mihara, Mt. Fuji and Quetta desert in Pakistan [1]. In Tokyo, where the still was placed on sand with high moisture content, the highest recorded daily yield was 1.1 l/m^2 and the yield during the night hours was, irrespective of the weather close to 0.2 l/m^2. In the desert area at the top of Mt. Mihara the still was placed at a depth of 4 to 5 cms; the daily yield was l/m^2. With the limited data of experiments during the rainy season it was estimated that the daily yield of the still at Mt. Fuji in good weather would be around 0.5 l/m^2 in the experiments in Quetta desert of Pakistan, the still was placed at a depth of 10 cms, and a daily yield of 0.4 l/m^2 was obtained. It was also observed that distillation occurred only during the night; the reason ascribed by Kobayashi was that only during the night the temperature of the cover was lower than that of the surface of the soil.

Ahmadzadeh has reported the output of the still at the Agricultural School of Pahlavi University, which is 20 km north of Shiraz, Iran as follows [2].

Depth of placement	Daily output
0.00 m	0.00 l/m^2
0.08 m	0.74
0.28 m	1.00 l/m^2

It is seen that the concept, limited experimentation and qualitative explanation of observations have been available for a long time. Further the potential of the still has not been explored in areas, where the soil is rich (almost saturated) in moisture like the sea shores, river banks and swamps. This paper reports laboratory experiments on the solar earth-water still, which simulate the conditions in areas, where the soil is rich in moisture. The results of the experiments are presented herein with a discussion.

Experiment

The solar water-earth still (S I) was fabricated by making 17 circular holes of 20 mm diameter and 4 circular holes of 10 mm in the bottom of a conventional 1 m×1 m, FRP single basin single slope solar still. The still was placed in a tray, full of sand, kept wet by slow flow of water, to simulate wet sand at sea shore and river banks; the still was full of sand to a height of 2.5 cms and coal dust was spread at the top of the sand (the water was filled to the level of sand in the tray). The still faced due south. The experimental set up is illustrated in Figure 1.

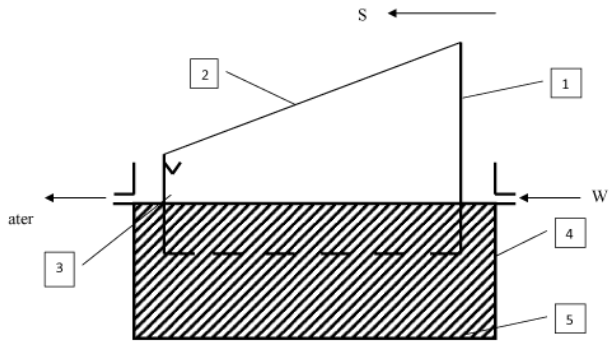

Figure 1: Schematic arrangement of solar water – earth still.

Simultaneous experiment was also conducted on a conventional solar still (S II), identical to the one, used for making the water earth still (without holes in the bottom).

The following measurements were made

Distillate yield at half hour intervals for 48 for both stills.

Solar radiation on horizontal surface at half hour intervals by means by SP-Light Silicon

Pyrometer.

Atmospheric temperature (in shade) by MDTI-039T digital temperature meter.

Temperature at the centre of glass cover and top surface of wet sand (for SI) and water (for SII) by MDTI-039T digital temperature meter.

Observations, Results and Discussion

Figure 2 Illustrates the observed time variation of the atmospheric temperature T_a and irradiance of solar radiation S during the period 6 AM of March 14, 2010 to 6 AM to March16, 2010 at Raipur (Latitude 21.16 N and longitude 81.42 E) India. The solar radiation, atmospheric temperature, the glass cover temperature and the temperature of water/wet sand were recorded every half hour.

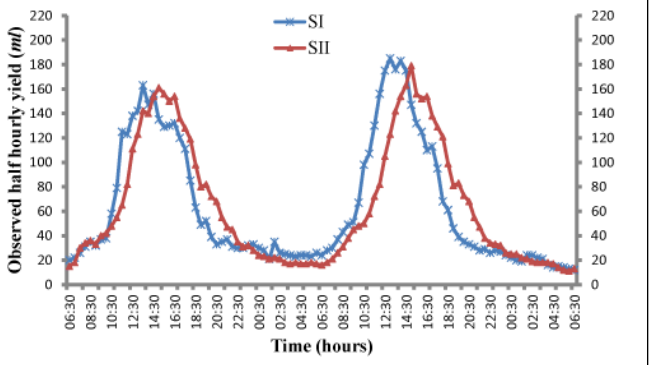

Figure 2: Time variation of solar irradiance on a horizontal surface and atmospheric temperature in the shade during the experiments

Figure 3 displays the time variation of the observed half hourly yield of the distillate of the two stills for a period of 48 hours. The time variation is similar in both the cases except for a phase lag; the conventional still lags behind the earth water still. This can be readily understood in term of the large heat capacity of water in still II, than the effective heat capacity of wet sand in still I. It is also seen that the phase of the yield lags that of the solar irradiance; the phase lag is more in case of the conventional still. This supports the conclusion of Figure 3 that the heat capacity of water in still II is larger than the effective heat capacity of wet sand in still I. Further the Dunkel's relation overestimates the distillate yield in Still I when the solar flux is large; this may be due to the inability of the moisture to diffuse to the surface of wet sand, to keep up with the rate of evaporation, demanded by Dunkel's relation. The departure from Dunkel's relation during the period of high solar flux in Still I is compensated by a higher temperature of the surface. It is seen that the daily distillation outputs for solar earth water still and the conventional still viz. (6.200/2=3.100) and (6.135/2=3.068) are almost the same, which is a significant conclusion [3].

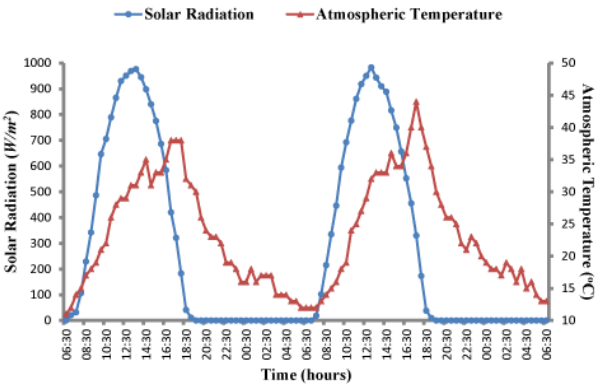

Figure 3: Observed half hourly distillate yield of I solar earth- water still and II conventional still; the yield for 48 hours in the case the I and II still was 6.200 liters and 6.135 liters respectively.

Conclusions

Experiments on the performance of a solar earth still, suitable for highly wet ground (beaches, swamps etc.) have been conducted at Raipur, India; this still was a conventional FRP single slope still with a number of large holes in the bottom. It is seen that the daily distillation yield is almost the same as that of the conventional still in March at (21.16N, 81.42E). An interesting conclusion is the fact that in still wet sand nearly behaves as a free water surface.

References

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