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ORIGINAL ARTICLE

Design and Experimental of Portable Conical Solar Still and Study Parameters

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ABSTRACT

The lack of drinking water in remote and semi-desert areas, as a result of the lack of fuel and its high price. The trend towards renewable energy, including solar energy, has increased. In this paper a conical type solar distiller has been manufactured and practically experimented with the purposes of distilling the water of wells in Mosul . He studied the high temperature distilled over time using a black distilled basin first. Then add the black marble to the basin secondly. And added bitumen the third. Found high water temperature, and glass whenever added heat absorbing and slowly lost substances. Also, the addition of these substances increased productivity and efficiency. Also demonstrated in practice the effectiveness of the distiller being exposed to solar radiation from all directions.

Keywords: Renewable Energy , Solar energy, Solar thermal ,Solar Distiller , phase change material .water purification , Remove salts from water.

INTRODUCTION

Due to the lack of potable water, there are no means of purifying water, especially in rural areas and far from cities. As well as the global water scarcity, and the recent phenomenon of desertification in many countries, including Iraq, and the lack of energy means, and to address this lack of water for researchers use solar energy in water distillation. From this research, Integrate a sole-slope SD solar distilling machine with a tubular solar heating system that has been used to heat raw water as it enters the distillation basin. Therefore, found the maximum productivity daily, during a typical summer day is (3.47 kg / m^2) , which approximately about 20% is more high than the traditional system of self-degradation. The result also showed that maximum efficiency was (33.8%) , almost(26%) highest , than system of sustainable development absenting such strengthening. Overall concluded the optimal depth of the water in basin is (0.03 m) [1]. Modify a graded sustainable developing system besides adding an outer condenser and inner and outer reflective surfaces. They collate the modified-model to the conventional sole – slope self-flow machine which found the productivity is about (66%) ,higher than using only the outer condenser and (165%) when using the outer condenser and, vice versa [2]. A very simple distilling system collate by focal point. The system has been collected then installed at very low-prices. The Paraffin was also used in this study as a form change material to absorb the heat from the water. The concentration machine, consisting of the dish, was used as a storing tool to heat raw water. The distillery was manufactured and added PCB under the base to accelerate the storing energy. Tests were made in Baghdad, Iraq during winter 2013-2014. This machine is appropriate for the desert and rural areas. The acceptable productivity collate to other machines. Adding., PCB to the concentrated distilling system, it accelerated the system's engaging(working) hours and accelerated the focus efficiency by (50.47%) , increased the heating efficiency by(157.8%), and increased system productivity by (783%). [3] . Use paraffin wax PCM in increasing anti-corruption solar absorption of single slope solar distiller system SD. Found that, the use of paraffin (PCM) as latent heat storage decreases the productivity of self-crystallizing system during the daylight by 7.4%. While increasing productivity by 72.7%. Total daily productivity was about (11.7%) higher when using PCBs [4]. The impact of the gap between the sink and the single-slope solar distiller system cover. The design parameters were fixed; (0.7m × 1.4m) from the dimensions of the basin, the angle of the slope of the casing (28 °) (which is the same angle of the latitude of the site), and the depth of the water (10 mm). They controlled the high gap between the sink and the cover using polystyrene caps within five stages and were from (0.266 m to 0.366 m) and concluded that the smaller lump gap between the sink and the cover) increased the productivity of the solar distiller system. According to the results, average daily productivity ranged from (1.341 L/m^2, to 4.186 L/m^2) and average daily efficiency ranged from (11.25%) to 39.59%. [5]. They tested a double- slop , system with rubber lid to cover the inner surface. Rubber clippers are like a windscreen wiper blade. The purpose of the rubber residue is to collect intensive water on the inner surface of the SD solar distillation system casing, which allows for the transfer of more photovoltaic energy (solar) and prevent intensive water from re-evaporation. The results showed that the average daily productivity was (4.24 L/m^2) and that the productivity enhancement was about (63%) due to the use of rubber residue enhancement [6]. They used the multistage model in 2D engineering under constant condition. The boundary conditions were such that there was no thermal flow of walls, a constant temperature of 30 degrees and 40 degrees for the glass cover and absorption board, respectively. They do not include the effect of solar radiation or the turbulence of the flow output [7] . A solar distillation system that can work on both solar and biogas energy, and tested its performance using experimental analysis conducted in case of different operating conditions and auxiliaries. The requirement for maximum distillation production has been set. The quality of distillation produced was found to be within an acceptable range [8]. Solar chimney, where process properties, such as temperature, water depth and salts concentration, have been tested for operating conditions. The depths of water range from in the experiment (1-2 cm) to a low salt concentration ranging from 3, 5-8%). The experimental data were verified and the verification results were 14%. It showed that desalination had improved by 30%. [9]. Graded solar power, separate condenser connection instabilities, flat panel collector (FPC), usage of nanoparticles Positive shoots are found to be less productive than active ones, and the thermal efficiency of active solar holes is 50–70%, which is significantly higher than that of negative shots, which is still 20–55%. The maximum daily output of solar energy stays at 10 liters for active solar energy and 6 liters per day for negative solar energy [10]. In the current research the design and manufacture of a single-sink portable solar distiller of the conical type with a slash and transparent walls of all directions to collect solar radiation from all directions with a single and inclined basin of all directions. The materials inside the basin have been added to help raise the temperature and continue to work the distiller effectively in removing salt from the well's water.

Theoretical part: The mechanics of heat transfer during solar distillation mainly depend on atmospheric effects, as well as the amount of solar radiation reaching the distillation basin. Where solar radiation reaches Earth. A section of it is scattered, another absorbs through the air. There are two types of heat transfer: internal and external. Radiation and conduction control external transfer., convection .The internal heat transfer occurs by radiation mediation, load and evaporation evaporation , as conduction and evaporation are double [11]",

convective heat transfer: The convective heat transfer is depend on equation (1)[12]

$$Q_{cw} = h_{cw}.A.(T_w - T_g) = h_{cw}.A.\Delta T \quad (1)$$

Where h_{cw} is heat transfer coefficient
ΔT is the driving force for thermal transport.
Transport coefficient h_{cw} , is a function of fluid properties, flow properties and operating temperatures[13].

$$h_{cw} = 0.884\,[[T_w - T_g + \frac{(p_w - p_g)(T_w + 273.15)}{(268.9\times10^3 - p_w)}]^{1/3} \quad (2)$$

Radiative heat transfer: For a small inclined distiller and a large width, the surface of water and cover are considered to be parallel surfaces. The rate at which radiation heat transfer from the surface of the water to the cover is given by equation (3)

$$q_{rw} = h_{rw}(T_w - T_g) \quad (3)$$

The Radiation heat transfer coefficient is given by equation (4) [14].

$$h_{rw} = \varepsilon_{eff}.\sigma\,[(T_w + 273.15)^2 + (T_g + 273.15)^2\,] \times [T_w + T_g + 546.3] \quad (4)$$

Evaporative heat transfer: The amount of distilled water is assessed using mathematical relationships (5,6)[54].

$$q_{ew} = h_{ew}(T_w - T_g) \quad (5)$$
$$h_{ew} = 0.01623\,h_{cw}(P_w - P_g)/(T_w - T_g) \quad (6)$$

Efficiency in solar distillation is defined as the relationship between heat used for fumigation to effective energy absorbed by water, as in the following by equation (7) [15] .

$$\eta = \frac{m \times L_w}{G \times A \times \Delta t} \quad (7)$$

m: Intensive water mass over a certain period of time and in a unit (gram(
L_w : Water latent heat (for evaporation) with j/gram module.
G: Solar radiation in unit (W/m^2(.
A: Effective area m^2.
Δt: Period of time (sec)."

Experimental Arrangement: The system was manufactured and tested within days of the month (4th, 5th and 6th), in Iraq - Mosul City, at the longitude (43.13^0), and latitude (36.34^0) .
A- Metal Basin: It has a square shape made of strips of iron with thickness (1.5) mm and length (1 m), width (1 m) and height (0.05 m). A portal was made from one of the bodies to remove sediment from the basin , as it has been painted from the inside with black paint to help absorb as much solar radiation as possible . A metal base is also designed to raise the system from the floor at a length of (0.030m) Figure (1) Shows the locally manufactured structure.

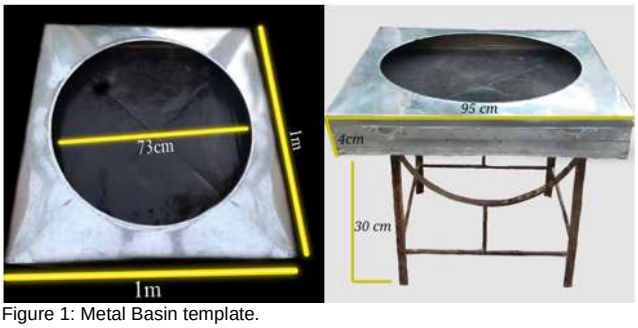

Figure 1: Metal Basin template.

Conical Slop: The conical inclined surface is also designed and as in figure (2). With a high-altitude metal mold, and in cone shape, segments of Perspex with high permeability were wrapping it inside a (75° C)) thermal oven and five minutes later it was taken out of the oven to be cone-shaped. At height (70 cm) and diameter of the base (74cm) and above (25cm) . A rubber hose was also installed after two halves and one equity were installed as a silicon-mediated water collection channel

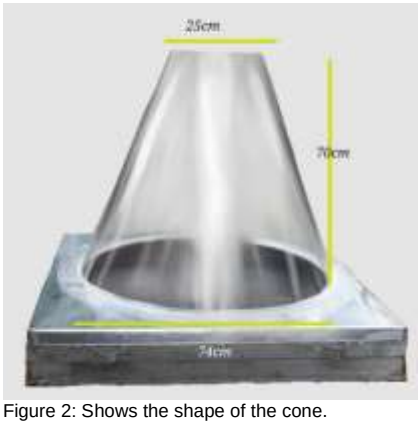

Figure 2: Shows the shape of the cone.

The system has been assembled to be operational and experimental, as in figure (3)


Figure 3: Conical distiller system during work.

RESULT AND DISCUSSION

The relationship between time and water temperature in the distilled was studied figure(4) . As well as the glass temperature of the inside of the conical distiller. General behavior is observed to be similar as the water temperature in the basin and glass increases over time, but with the addition of (black marble) The temperature of water and glass increases more over time, as well as the higher temperature of water and glass is observed when using (Black bitumen), the substances are highly heat absorbing

and heat-diving for longer time so the temperature of water and glass is raised in greater conformity with.[16].

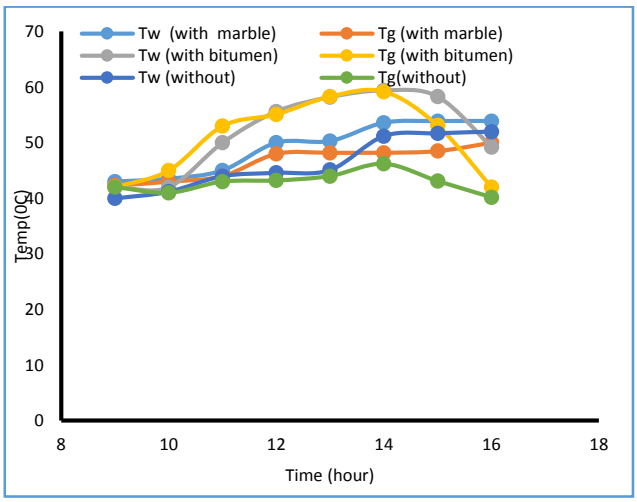

Figure 4: The relationship between time and temperature in the distillation.

A liter of well water was added and the distillation process was examined from the morning until 5pm figure (5). An increase in the productivity of distilled water was observed over time due to increased temperature resulting from the increase in solar radiation. The experiment was re-experimented in similar conditions after the placement (alabaster, black stone) in the basin an increase in water productivity was observed. The experiment was also re-tested when placing (bitumen in the basin)also ,an increase in productivity was observed more than previously that the added substances raised the water temperature faster and served to store the heat longer so improved productivity and is consistent with [4,17].

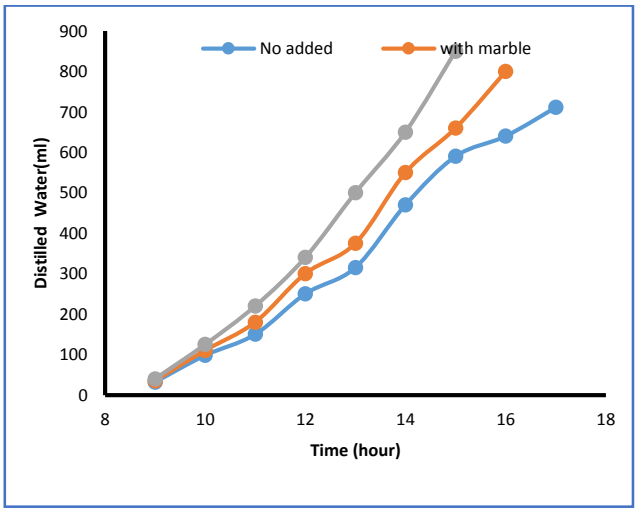

Figure 5: Relation between time and water distilled at added marble ,bitumen in basin .

Efficiency was also studied ,when using a one litter of well water in the distiller on a clear day . At different basin variables once without additives, and second using (black stone marble) , thirdly, when using (bitumen), efficiency has been observed to rise for three cases , but more so when using (bitumen), as shown in the figure (6) Due to the increased heat that these substances absorb the heat significantly and retain it for longer time so the evaporation speed increased when using the driveway in the pelvis and more when using the bitumen and is compatible with [18]. .

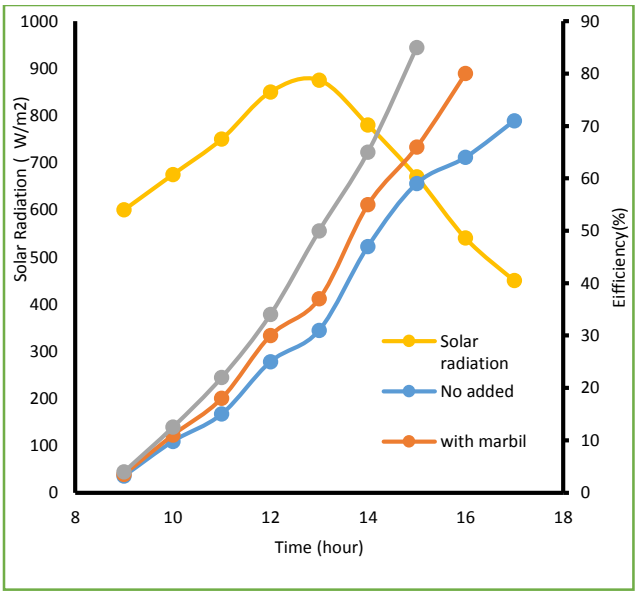

Figure 5: Relation between time and solar radiation and Efficiency .

CONCLUSION

In this study, experiments and analyses were conducted in Iraq-Mosul Summer's atmosphere under difficult environmental conditions where drinking water is scarce. In addition to the high intensity of solar radiation, although sometimes the atmosphere is dusty and saltwater abounds from the boreholes, and even the poor filtering stations in this area used a conical distillation with transparent cover from all sides, the results of this study were. Good that the distiller is exposed to solar radiation from all sides and at all times in experiments, helping to raise temperatures as well as heat water and condense steam quickly. Solar distiller was practically studied using a black distilled basin and some phase-changing materials such- as bitumen ,and marble were added .The addition of variable-phase materials It worked to raise the water temperature in the basin and increased efficiency reduced distillation time.

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