MODIFIED DESALINATION SYSTEM WITH WATER COOLED CONDENSER OPERATED BY THE SOLAR PV PANEL

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Solar energy; Desalination; Simple solar still; Glass pebbles; Sand bed; Heat exchanger

Introduction:

Fresh water scarcity has become a growing serious problem due to pollution and overexploitation of water resources. The dependency on traditional methods utilizing renewable energy source for healthy and safe water is grooming across the world. The presence of water is that fundamental necessity for all the people.

Changkang Du and Congliang Huang [1] conducted experiments on floating vapour condensation system using solar energy as a heat source. Van-Huy Trinh et al. [2] developed a sustainable desalination device which is capable of developing producing fresh water and electricity. Extensive review on performance of enhancement techniques for pyramid type solar still has been conducted [3]. Hiroshi Tanaka [4] carried out a theoretical analysis of a vertical multiple-effect solar still coupled with a tilted wick still.

Based on the literature review, the objectives have been set to enhance the fresh water yield of simple solar system by using the different heat storage materials and heat exchanger.

Objectives:

1. To fabricate the modified solar desalination system.
2. To study the yield of drinking water by cooling the condenser of solar still with surrounding air.
3. To study the yield of drinking water by cooling the condenser of solar still by spraying the cooling water on it.
4. To study the yield of simple solar still.
5. To study the simple yield of solar still with sand bed, glass pebbles as a heat storage material.

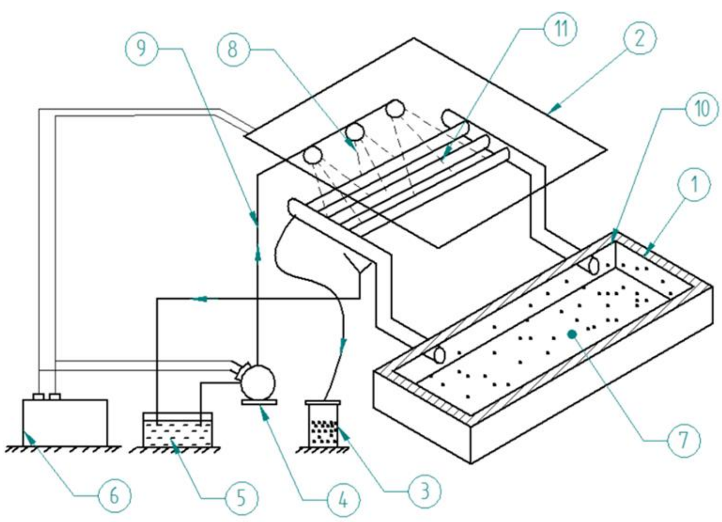
Methodology:

A schematic description of the proposed solar still is shown in Fig. 1. The still absorber is a rectangular galvanized plate of with 1 mm of thickness and painted with black spray paint to increase the solar absorption. The absorber is placed in an airtight wooden box with a double-glazing cover encloses the still surface. The double-glazing horizontal cover of 3 mm thickness for each glass is used. In addition, a gap of 15 mm between the glasses is kept.

The condenser is a horizontal tubular heat exchanger in which the water steam is separated from the air and forms a condensate film. The heat exchanger is made of three parallel copper tubes. Copper is selected for its high conductivity and lightness. The condenser is shaded from sun radiation by a PV panel (sun-shade) cover placed above the condenser and spaced at 25 cm allowing the ambient air circulation around the condenser tubes. The electricity generated by the solar PV panel is used to run the pump to circulate the cooling water to the condenser to enhance the cooling of vapours. The link between the evaporator and the condenser is performed by two vertical PVC tubes. These tubes were insulated by a glass wool layer of 2 cm of thickness and can be considered adiabatic.

The solar radiation passes through glass cover is absorbed by the galvanized plate and then transferred to brackish contained in the basin within the still. The generated vapor is transferred to the flowing air which being heated and its density is decreased. In the condenser, the humid-air is being cooled and its density is increasing. The thermo-syphon effect acting to force the warm fluid to leave the heater and to go upwards through the hot-leg and directed to the condenser. After leaving the condenser, the cold dry air become heavy and returns toward the heater and repeat the process. So, a continuous circulation is takes place in the still enhancing both evaporation and condensation process and contributing to further increase in the still productivity. The water steam is separated from the air forming a thin liquid film which trickles down under the gravity effect and the little inclination of the condenser tubes. After that, the condensate film formed in the tubes trickles toward the water collection bottle.

The results of modified desalination system also compared with that of simple solar still with sand bed and glass pebbles as a heat storage material.



1	Solar still (Evaporator)	7	Brackish water
2	PV Panel	8	Cooling water spray
3	Distilled water	9	Cooling water
4	Pump	10	Glass cover
5	Cooling water	11	Condenser
6	Solar powered battery		

Figure 1. Schematic diagram of the experimental setup.

Conclusion:

The experimental work has been carried out to study the yield of simple solar still and with sand bed, glass pebbles as heat storage material. The results are compared with the modified solar desalination system with heat exchanger. Based on the experiments, following conclusions are drawn.

1. Fabricated a simple solar desalination system and simple solar desalination system with heat exchanger.
2. The brackish water temperature has been increased by 14% and 25% in a time duration of 13 hours and 14 hours for the solar still with glass pebbles as compared to simple solar still.
3. Because of the highest temperatures in the solar still with pebbles, there is an increase of water yield by 6 to 180% as compared to simple solar still.
4. The maximum yield is obtained at 15 to 17 hours, due to the heat liberated by the glass pebbles in the still.
5. Solar still with sand bed has increased the output by 3 to 45% as compared to simple solar still.
6. The Lowest water yield is obtained for the solar still with heat exchanger due to difficulties in condensing the water vapours in the heat exchanger.

Scope for future work:

Based on the experiments conducted, the yield of freshwater can be enhanced by the following methods.

1. The stepped basin and wick material can be employed for improving effectiveness.
2. Transparent glass cover with different materials can be employed.
3. Solar refrigeration can be coupled with desalination system to enhance the output.

Reference:

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