Prince Sattam bin Abdulaziz University
College of Engineering
Mechanical Engineering Department

Performance Enhancement of Cylindrical Solar Still by Water Spraying Unit and Air Bubble Injection

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Abstract

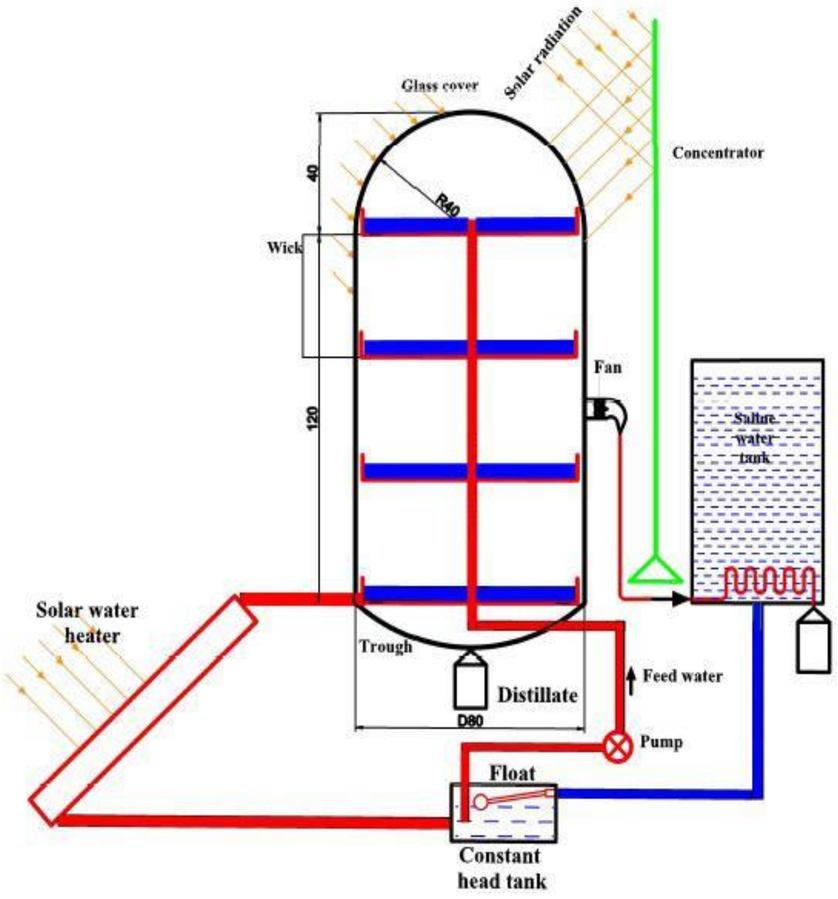
Solar stills, the most fundamental technology for harnessing solar energy for freshwater acquisition, utilizes a straightforward process. Sunlight directly evaporates fresh water from seawater or brackish water sources. This study investigated the potential for augmenting solar stills' productivity and thermal performance. To achieve this objective, a novel design, the cylindrical solar still (CYSS), was employed. The multi stages absorber serves the dual purpose of significantly increasing the surface area dedicated to evaporation while concurrently reducing the thickness of the brine layer. This innovative design resulted in a remarkable enhancement in freshwater production. The cylindrical SS generally exhibits a higher average temperature of glass compared to the conventional SS. This results from the significantly larger surface area of glass cover of the cylindrical SS (2.35 m²) compared to the conventional SS (0.61 m²). This difference translates to a 482% improve in the cylindrical SS surface area.

Objective

- Increased production of fresh water in solar stills with multi stages absorber.
- Improved efficiency of solar still.
- Reduced heat loss in the solar still.
- Maintaining the small size of the solar still, without increasing the size.

Working principle

The working principle involved sunlight traversed a transparent plastic cover and impinged upon a multi stages absorber which had been sprayed with saltwater by a distributor tube. This solar energy absorption led to the heating and evaporation of the saltwater. Subsequently, the vaporized water condensed on the cool interior surface of the plastic cover, and the resulting freshwater flowed down to distillate tank.



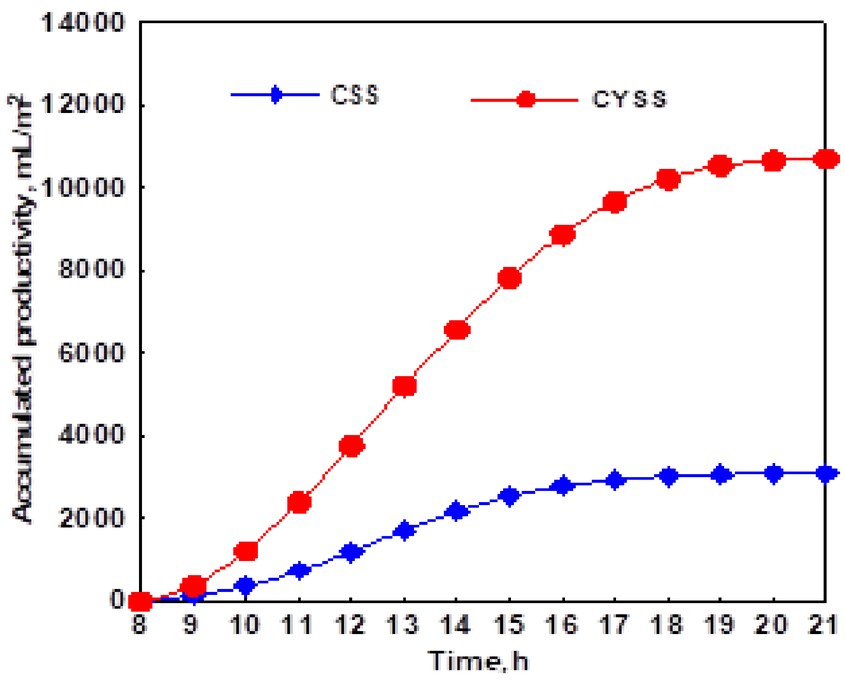
Schematic diagram of cylindrical solar still shape with multi stages absorber

Experiment setup

A field experiment at Prince Sattam University (KSA) on May 2ed, 2025.Assessed solar stills facing south under natural sunlight for a full day. From 8 AM to 4 PM, data on solar radiation, temperatures, and distillate production was continuously collected. CSS and CYSS they were placed next to each other and tested together to compare the results., and key data points were meticulously recorded throughout the experiment.

Results and discussion

The SS and multi-stage cylindrical SS are displayed in Fig. 5. The findings unequivocally show that, in terms of overall yield, cylindrical SS consistently outperformed conventional SS. The conventional SS reaches 470 mL/m²h at this peak, but the cylindrical SS reaches a maximum yield of 1450 mL/m²h. Additionally, the traditional SS produced 3050 mL/m² every day, whereas the cylindrical SS produced 10600 mL/m². This corresponds to a noteworthy 248% increase in production that the cylindrical SS attained.



Conclusion

Experiments with a cylindrical solar still shape with multi stages absorber (CYSS) showed impressive results. CYSS produced 248 % more fresh water than a conventional still, this configuration optimizes solar radiation utilization across the cylinder’s longitudinal axis and hemispherical cover while reducing internal air volume by 36% relative to the CYSS without absorber chambers. The compact chamber design lowers thermal inertia, enabling faster heating of trapped air and enhancing vapor generation rates.