



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

A Review: Various Methods to Enhance Distillate Output of Hemispherical Solar Still

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ABSTRACT: Approximately 97% of the water on Earth is salty or polluted, only 3% water is fresh and among its only 1% is easily accessible for human use. With the increase in population day by day fresh water demand is also increased accordingly. To address this problem generation of pure water with desalination process is necessary. But the desalination process should be with the natural sources otherwise there are negative impact of it due to its carbon footprint. A well design solar desalination system may provide a sufficient quantity of water to communities. The productivity with the current methods and models is quite less in comparison with the demand. There are various strategies to create clean water but the hemispherical solar still is one of the best alternatives for meeting the need of fresh water in rural and distant location. Generally HSS have better thermal performance than other type of Solar still. Modification is required to enhance the productivity so in the present work we reviewed various methods to enhance distillate output of hemispherical solar still.

KEYWORDS: Energy storage materials; Glass top cover; Hemispherical Solar still; Internal reflectors; Metal trays; Nano fluid; Sand Grains.

I. INTRODUCTION

Clean fresh water is not only important for the existence of life, but it is also important for cooking and the growth of food crops, as well as for the environment as a whole. The lack of clean drinking water in some parts of the world can lead to illness, diseases, poverty, and even war. Solar distillation is a simple and practical way of producing water, if not gallons of fresh solar still water for both drinking and watering the garden.

Solar energy is renewable energy source available all over the world that never runs out. The sun's solar thermal energy is free, clean, available all year around, and unlimited, so why not make use of it to produce clean water as solar still water distillation systems are among the simplest water purification system you can build.

Furthermore, it is useful to mention that the (HSS) consists of a circular basin and an absorber plate. The distillate water is collected in the conical-distillate port located at the bottom of the circular basin. Researchers referred that the water depth was inversely proportional to the productivity and efficiency of the hemispherical solar still.

This is the mini review carried out to find out the various methods to enhance distillate output of hemispherical solar still.

II. EFFECT OF TOP COVER COOLING

In this research work (Mohdzaheen khan et al. 2020) obtained the distilled water from a new design solar still say, a hemispherical solar still because in this work, the author use hemispherical shape glass, as a top cover by flowing the water over the cover. By flowing the water over this hemispherical cover, they decrease the cover temperature and this will increase their daily yield of the system. This observation was seen in Department of Mechanical Engineering, faculty of engineering, Jamia Millia Islamia, New Delhi (longitude 77°12'0.195600 E and latitude 28°35'41.280000 N), India. By using this water-cooling effect on the top of this hemispherical solar still, they generally enhanced the vapour condensation rate and hence the distilled water yield. It was found that water film cooling

enhanced the daily production from 3.7 l/m² to 4.2 l/m². The average efficiency was increased from 34% (HSS) to 42% (HSS-C) which is equivalent to 23.5% increment.

III. USE OF METAL TRAYS

In this Experiment, a hemispherical solar still with different metal trays (copper, zinc, and iron) painted with black was studied experimentally by Mohammed El HadiAttia, A.E.Kabeel et.al. 2021 Four hemispherical solar stills were manufactured; the first is the conventional hemispherical solar still which represent the reference case (CHSS), the second, third and fourth were the modified hemispherical solar stills with adding black metal trays of copper, zinc, and iron, respectively. These trays were placed at the bottom of the distiller basin.

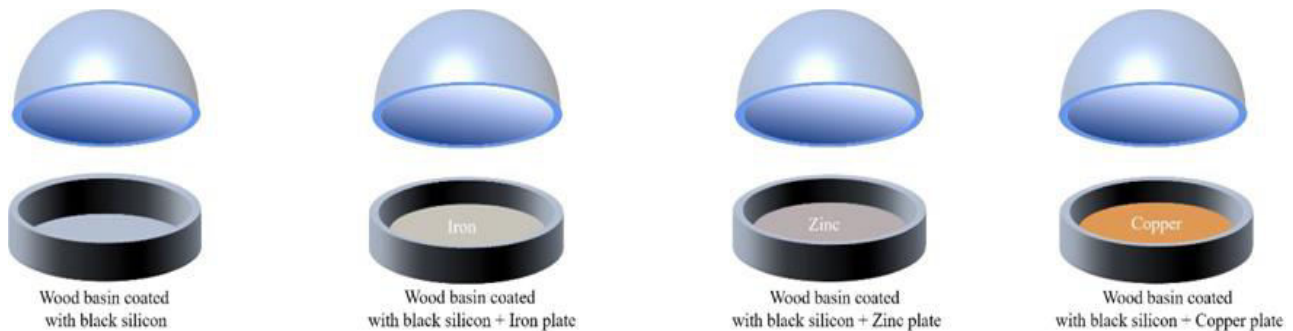


Fig.1 Schematic diagram for of CHSS and THHS with different metal trays. (a) CHSS (b) THSSI (c) THSSZ, and (d) THHSC

The measurements were taken during three days in July in El Oued city, Algeria, where the maximum solar radiation was 1015 W/m². The daily production and efficiency of CHSS, THSSI, THSSZ and THSSC were 4.8, 5.5, 6.3 and 7.35 L/m², and 37.4%, 42.8%, 49%, and 57.2% respectively. It can be concluded that the inclusion of metal trays resulted in increasing both the daily production and the efficiency by 17% and 14.4% for Iron (THSSI), 31.25% and 31% for Zinc (THSSZ), and 53.125% and 52.9% for Copper (THSSC) in comparison to CHSS. THSSC attained the highest daily production rate due to the high thermal properties of copper in comparison with other used metals.

IV. EFFECTS OF AL₂O₃ -WATER BASED NANO FLUID

In present experimental setup, three fixed hemispherical distillers were designed and constructed to obtain the influence of AL₂O₃ -water based Nano fluid and cooling technology of glass cover by water sprinkler on the accumulative yield of hemispherical distillers by (AbdelkaderBellia et al 2021)

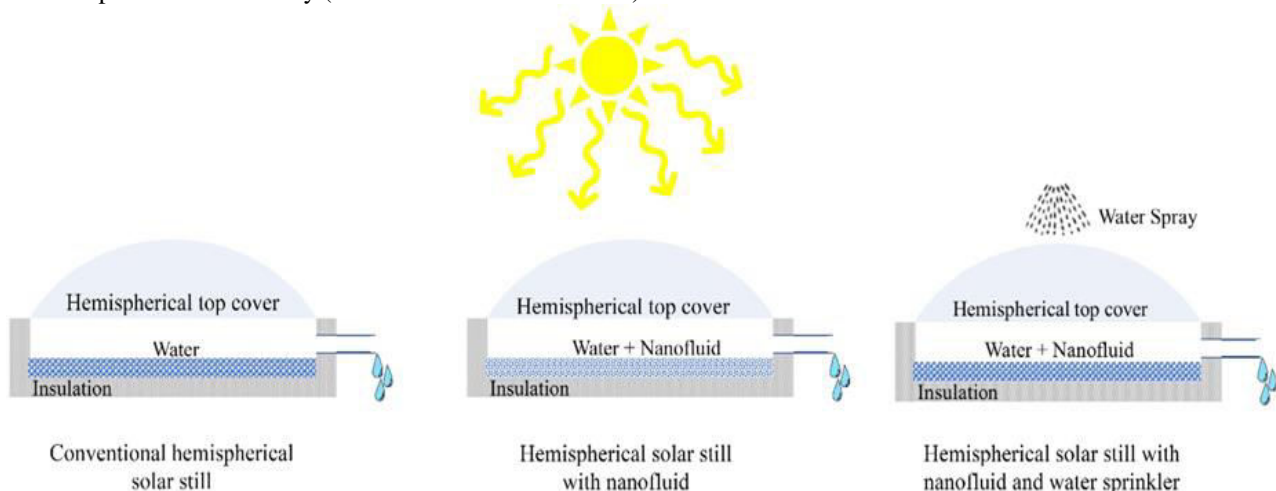


Fig.2 Schematic view of the test rig

In this research author added AL₂O₃ nanoparticles with different concentrations to the basin’s water to increase the

evaporation rate and utilize sprinklers to reduce glass cover temperature and compared it with CHSS. The daily efficiency of CHSS reached 31.8% while for MHSSN and MHSSNS, the daily efficiency reached 50.9% and 70% respectively.

V.USE OF PHOSPHATE PELLETS AS ENERGY STORAGE MEDIUM

In this experimental work, the performance of hemispherical distiller has been enhanced via phosphate pellets by (Mohammed El HadiAttia et al 2021). To investigate the best approach to the phosphate pellet utilization in a basin of hemispherical distiller to achieve the highest performance, the present study was carried out in two stages. In the first stage, 250 g of phosphate pellets was arranged in a layer of 5 mm thickness placed at the bottom of the basin. In the second stage, the phosphate pellets were distributed in a homogeneous manner in basin salt water with two concentrations 1% (10 g/L) and 2% (20 g/L) without aggregation on the basin. To achieve this idea, in the first test stage, two distillers were compared, the first is the conventional hemispherical distiller which represents the reference distiller (CHSS) and the second is the modified hemispherical distiller with a phosphate layer (MHSS-PL). In the second test stage, three distillers were compared, the first is the CHSS which represents the reference distiller, the second is the modified hemispherical distiller which contained 1% phosphate (MHSS-1), and the third is the modified hemispherical distiller which contained 2% phosphates (MHSS-2).

The experimental results show that the cumulative yield was 4.6, 6.32, 6.15, and 6.85 L/m²•day for CHSS, MHSS-PL, MHSS-1, and MHSS-2, respectively. The results showed that the utilization of the phosphate pellets as a storage medium enhanced the performance of the hemispherical distiller. The enhancement in the distiller productivity was 37.4, 33.7, and 47.9% for MHSS-PL, MHSS-1, and MHSS-2, respectively, compared to conventional hemispherical solar still (CHSS).

VI.USE OF INTERNAL REFLECTING MIRRORS AND SEND GRAINS

In the present experiment (Mohammed El HadiAttia et al 2021) analyzed the influence of using internal reflective and sand grain with 3% concentration as ESM on the thermal performance of HSS. The authors compared the thermal performance of four HSS with different modifications, namely HSS-IRM, HSS-IRAF, HSS-IRM & SG, and HSS-IRAF & SG, with the thermal performance of CHSS. Two separate sets of experiments were conducted, in each experimental set, three HSS were considered. For the first experiment, they considered CHSS and HSS with internal reflective (HSS-IRM and HSS-IRAF) (Fig.3.a), while for the second one, they used CHSS and HSS with both internal reflective and ESM (HSS-IRM & SG, and HSS-IRAF & SG) (Fig.3.b). Both experimental sets were conducted during August under the same weather conditions.

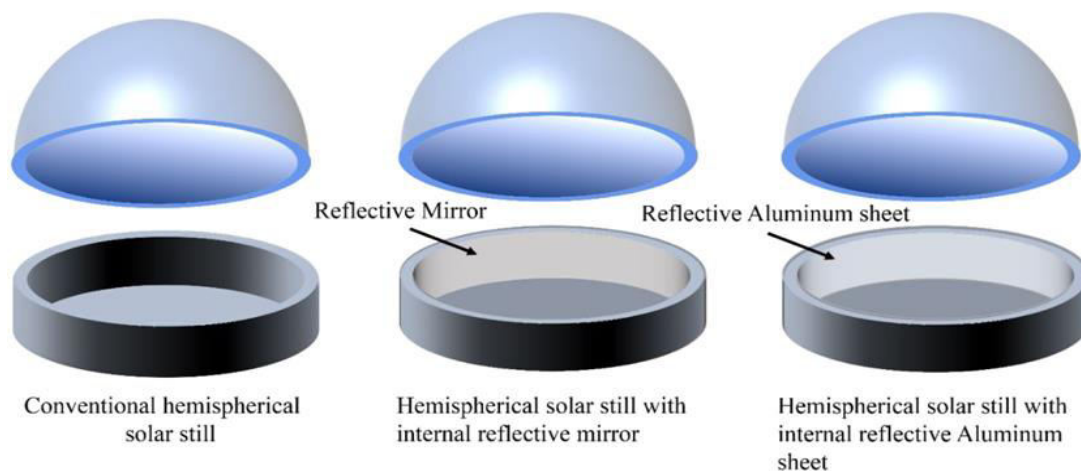


Fig.3.a First experiment

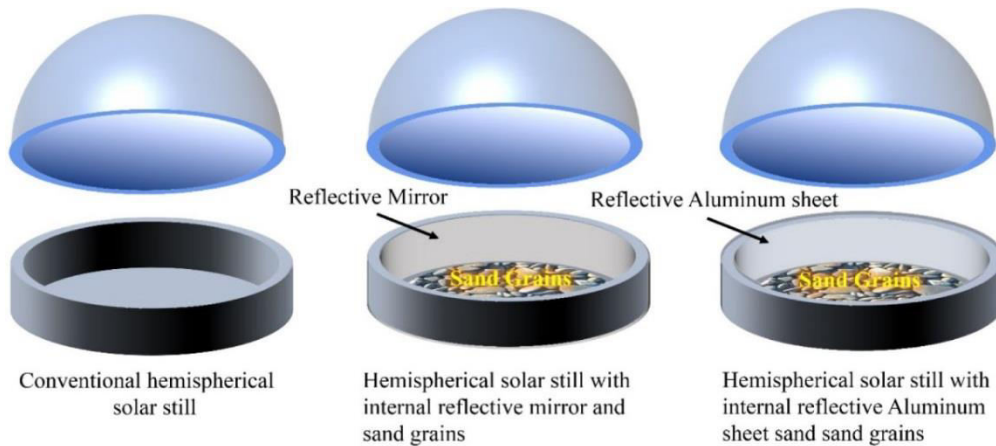


Fig. 3.b Second Experiment

The results indicated that the internal reflective and ESM improved the thermal performance of HSS. It was noticed that internal reflective enhanced the accumulative yield from 4.75 L/m² for CHSS to 6.2 L/m² and 7.15 L/m² for HSS-IRAF and HSS-IRM. While the addition of ESM further boosted the accumulative yield to 8.35 L/m² and 9.4 L/m² for HSS-IRAF & SG and HSS-IRM & SG, respectively, It was also reported that the thermal efficiency of HSS was augmented from 38.9% to 50.65%, 58.3%, 67.9%, and 76.3% for HSS-IRAF, HSS-IRM, HSS-IRAF & SG, and HSS-IRM & SG. The authors concluded that the best thermal performance was attained by HSS-IRM & SG, as it achieved an improvement of 98% and 96% for accumulative yield and thermal efficiency, respectively.

VII. HEMISPHERICAL SOLAR STILL: RECENT ADVANCES AND DEVELOPMENT: A REVIEW

Obai Younis et al. 2022 carried out an in-depth examination and recent development of various hemispherical solar still designs. A variety of parameters including top cover shape, saline water depth, top cover material, wick, glass cover thickness, insulation material, insulation thermal conductivity, metal tray, energy-storing materials, the temperature difference between the basin and cover surface, inclusion of fins, fin height and spacing, internal reflective, and adding of Nano fluids etc.

VIII. CONCLUSION

- It has been found that the hemispherical solar still has relatively better thermal performance than other types of solar stills.
- The increment of saline water depth had a negative impact on HSS efficiency.
- Using sand grains enhanced the performance of HSS, however, higher concentrations of sand grain might have a negative impact on its thermal performance.
- The use of fin sets has great potential to enhance HSS productivity. While increasing fin height has a negative effect on its performance.
- Adding Al₂O₃ nanoparticles to the water basin considerably improved HSS thermal performance. The optimum concentration of Al₂O₃ and CuO nanoparticles was 0.3%.
- The best thermal performance was attained by HSS-IRM (Internal reflective film) & SG (Sand Grains), as it achieved an accumulative daily yield of 9.4 l/m², a daily thermal efficiency of 76.3%, and a CPL of 0.0058 \$.

RESEARCH GAP

- Many researchers have worked on solar still but still work on hemispherical solar still is comparatively less in India.
- Different energy storage materials are used in CSS and HSS but still we can use some other materials as a ESM.
- We can study with various parameters like using fins,
- Reflective mirrors, various Nano fluids, top cover cooling effects, evacuated tubes etc. with HSS to enhance



the distillate output.

- Use of condenser (Inside, outside and inbuilt) with HSS is not done yet.

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SJIF Scientific Journal Impact Factor

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