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Review On Research And Development Of Solar Stills

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Abstract: Solar distillation is a promising method for desalinating saline water that can partially fulfill humanity's need for freshwater, requiring only simple technology and clean energy. Solar distillation systems have shown to be effective when weather conditions are favorable and the demand is not too high. However, low daily productivity of such systems has been a challenge, leading scientists to investigate ways to improve still productivity and thermal efficiency to reduce water production costs. This paper provides an overview and technical assessment of the latest developments in single and multi-effect solar stills, including still configurations, operational challenges, and environmental impacts.

I. INTRODUCTION

Potable water is necessary for the survival of life on this planet; however, due to increasing global population, the demand for safe water for drinking and various applications is increasing . In addition, the sustainability of energy and food sources is a major goal of all countries associated with artificial intelligence applications ; therefore, there is a considerable demand for the use of renewable energy sources . Many regions in the world, especially in remote areas and far from cities, suffer from energy shortages but have an abundance of solar energy throughout the year .

1. Single-slope vs double-slope basin stills: Comparison of the two configurations of basin type stills, single slope and double slope, shows that on the basis of motion of the sun, in different seasons and locations, the maximum radiation may be higher in double-slope stills and the performance may be better. On the other hand, single slope has less convection and radiation losses, and the shaded region may be utilized for additional condensation as will be seen below. On the basis of yearly performance data for Delhi climatic conditions, Tiwari and Yadav [1] concluded that a single slope still gives better performance than a double slope for cold climatic conditions. For summer climatic conditions the double slope gives better performance.

2. Still with cover cooling: Evaporation rate can be increased if the difference in temperature between the basin (heat sources) and the glass cover (heat sink) increases. This can be achieved by either increasing the basin temperature or decreasing the cover temperature or both. Two cooling arrangements have been suggested, both using a double glass cover. These two methods are shown in Fig. 3, and are termed feed back flow and counter flow. Results have shown that cover cooling produces an increase in the productivity of the still, with the improvement when using the feed back flow being greater than when using the counter flow.

3.Sun tracking systems were used by some researchers to enhance the distillation production a sun tracking system for use with various collectors and platforms was studied. An experimental investigation on a collector consisting of six parabolic troughs with trackers was conducted , whereas a tracking system which can be used with single-axis solar concentrating systems as an enhancer was described by others . An experimental study to investigate the effect of using two axes sun .

II. LITERATURE REVIEW

The group of authors of the review paper that we are referring to Akash Chavda et al [1] freshwater is a vital resource for humans and other living species. However, only 2.5 percent of the world's water is potable, and access to safe drinking water is limited to one-third of the population. The solar still is a portable water purification method based on the natural principle of the hydrological cycle. In recent work, various techniques have been reviewed to improve the performance and output of the solar still distillation method. These techniques include single slope solar still with sand troughs interaction, impact of glass cover, passive solar still with a twin wedge-shaped glass cover, pyramidal solar still experimental analysis, and the use of passive baffles to boost single slope solar still.solar still.

Access to pure drinking water is a fundamental right for all living beings Yogendra Kumar Raj et al [2] as well as agriculture and industry. Solar desalination is a non-traditional method that uses the sun's energy to remove salt and other impurities from saline water, producing pure drinking water. It is particularly useful in hot and isolated areas where water and energy are scarce. In recent years, there has been a lot of attention given to improving solar still designs, such as the pyramid solar system, to increase efficiency and cost-effectiveness. Studies have shown that pyramid solar stills are more efficient and cost-effective than traditional designs. This article reviews the evolution of pyramid solar stills and explores various strategies for enhancing their performance. The article also describes the different manufacturing techniques for pyramid solar stills. Despite its benefits, solar desalination still faces challenges research.n this study.

Mohammad Abd et al [3] Several types of solar stills were studied such as ,(single slope single basin solar stills, double slope single basin solar stills, tubular Solar Still, spherical solar stills, hemispherical solar stills, tringular solar stills, Pyramid-Shaped Solar Stills, Semi-Cylindrical solar stills, ‘V’-Type solar stills). And their converting salt water to fresh water. TSS solar has always achieved optimum efficiency. Hence from the above mentioned researches , From the above-mentioned research it was found that the wind speed, the intensity of the solar radiation and the Water depth: have An impact on freshwater output quantities. and the different design solar stills yielded different results.

i. Passive solar stills **:** Still solar systems that use solar energy as their primary source of heat energy And those that are combined with solar thermal energy are directly used to heat water and then produce the distillation effect. The low operating temperature and vapor pressure explain this development rate .

ii. Active solar stills : Extra thermal energy of this form is combined with passive solar for faster evaporation and this extra thermal energy can be collected from a solar collector or any excess thermal energy generated from any industrial plant.

In this study, we attempted to use a solar still to remove fluoride from drinking water, B.B. Sahoo et al [4]. Tests have been conducted to find the fluoride removal amount of collected samples, hourly output rate and the ‘‘still efficiencies’’. The pure water output rate is also tested by varying the input rate of the basin and with suitable modification to the setup. The findings of the investigation could be summarized as follows.

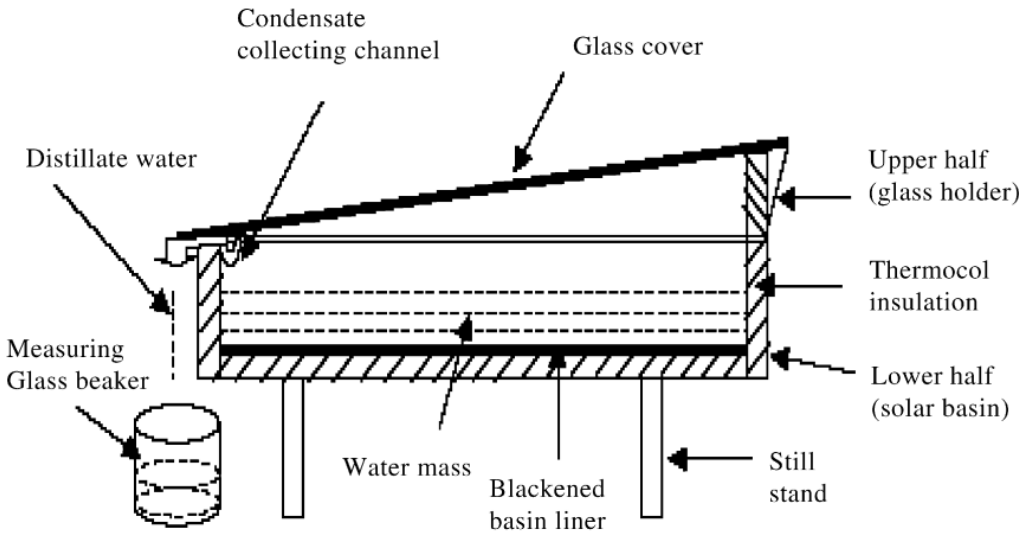


Fig. 1 Inclined wooden solar still.

Lujain S. Hyal et al [5]. Although water covers more than two-thirds of the planet, improving technologies for producing drinkable water remains a significant issue due to the increased demand for treated water. Solar desalination presents a simple, cost-effective, and environmentally-friendly solution that utilizes solar energy, which reduces the pollution effects produced by burning fossil fuels. This technique can provide pure water to people in rural and distant locations using a solar still, which is one of the most significant feasible uses of solar energy and an excellent source of fresh water. However, due to the low productivity of conventional solar stills, numerous experiments have been conducted to increase the daily output of solar stills by employing various active strategies to produce more evaporation and condensation than a simple standard-type distiller. This review focuses on recent methods used to enhance water productivity and their roles in augmenting productivity, performance, and thermal effectiveness of various solar distiller designs based on previous studies. Future suggestions based on identified research needs are also highlighted. This review is considered a reference guide to focus on the most efficient techniques.ost efficient techniques.

Vikash Kumar Chaubeyet al [6]. The experimental results of the conventional solar still and the stepped solar still indicate that the stepped solar still has a higher temperature increase and distillation rate compared to the conventional solar still. Additionally, the stepped solar still is more efficient than the conventional solar still.he conventional solar.

Pavan V et al [7]. Solar stills are a great way to produce clean drinking water using renewable, pollution-free solar energy. There have been many research studies conducted in this field to improve the efficiency and effectiveness of solar stills. One innovative design that has been studied is the pyramid-shaped solar still. The results of a comprehensive review on this type of solar still indicate that it is more efficient than conventional solar stills. The performance of a pyramid-shaped solar still is influenced by the quantity and quality of saline water, just like conventional solar stills. When using forced convective heat transfer in a pyramid solar still, the daily production of distilled water increases as the Reynolds number and wind velocity increase. To achieve the maximum yield per day in a pyramid solar still, the angle of the glass cover should be set to the local latitude.ept equal to local latitude.

Tri Hieu Le et al [8]. Passive solar still is the simplest design for distilling seawater by harnessing solar energy. Although it is undeniable that solar still is a promising device to provide an additional freshwater source for global increasing water demand, low thermal efficiency along with daily distillate yield are its major disadvantages. A conventional solar still can produced 2 to 5 L/m2day. Various studies have been carried out to improve passive solar stills in terms of daily productivity, thermal efficiency, and economic effectiveness. Most of the researches that relate to the daily output improvement of passive solar still concentrates on enhancing evaporation or/and condensation processes. While the condensation process is influenced by wind velocity and characteristics of the condensed surface, the evaporation process is mainly affected by the temperature of basin water. Different parameters affect the brackish water temperature such as solar radiation, design parameters (for example water depth, insulators, basin liner absorptivity, reflectors, sun tracking system, etc). The inclined angle of the top cover is suggested to equal the latitude of the experimental place. Moreover, the decrease of water depth was obtained as a good operational parameter, however, the shallow water depth is required additional feed water for ensuring no dry spot existence. Reflectors and sun-tracking systems help solar still absorb as much solar intensity as possible. The internal reflector can enhance daily yield and efficiency of stepped solar still up to 75% and 56% respectively, whereas, passive solar still with the support of a sun-tracking system improved daily yield up to 22%. Despite large efforts to investigate the impact of the different parameters on passive solar distillation, the effect of the basin liner (including appropriate shapes and type of material), needs to be analyzed for improvement in practical utilization. The present work has reviewed the investigation of the solar still performance with various types of basin liner. The review of solar stills has been conducted critically with rectangular basin, fins basin, corrugated basin, wick type, steps shape, and cylindrical shape basin with variety of top cover shapes. The findings from this work conclude that the basin liner with a cylindrical shape had better performance in comparison with other metal types and provides higher freshwater output. Stepped type, inclined, fin absorber, and corrugated shapes had the efficient performance. Further exploration revealed that copper is the best-used material for the productivity of passive solar still.

V. Sivakumar et al [9]. Solar desalination is a technique used to convert brackish or saline water into drinkable water. This method is becoming increasingly important due to high population density and industrialization. The conversion process is achieved using solar energy and the device used for the process is called a solar still. There are two major types of solar stills: active and passive solar stills. With a passive solar still, freshwaer is produced without the need for high-grade energy (such as electrical energy). The yield from either type of solar still depends on various factors such as meteorological conditions, design, and operational parameters. While humans cannot control meteorological parameters, researchers have worked to optimize the design and operation of solar stills. They have used mathematical expressions and conducted experiments to validate the performance of various types of solar stills. This paper reviews the methodologies used in the past to improve the performance of active and passive solar stills.

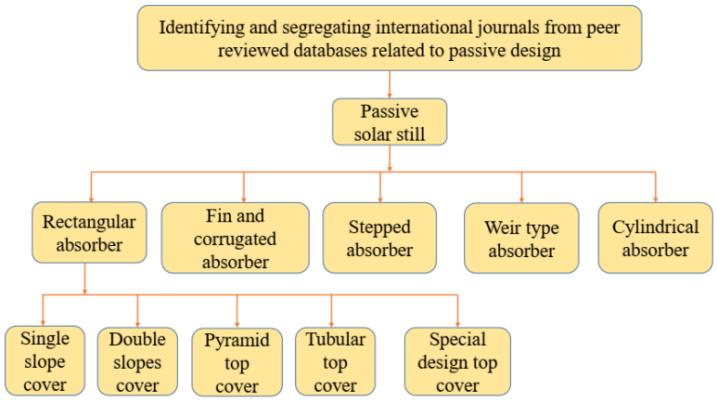


Fig.3 Block diagram of solar still type

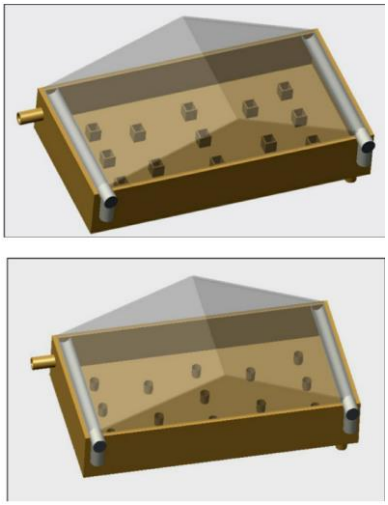


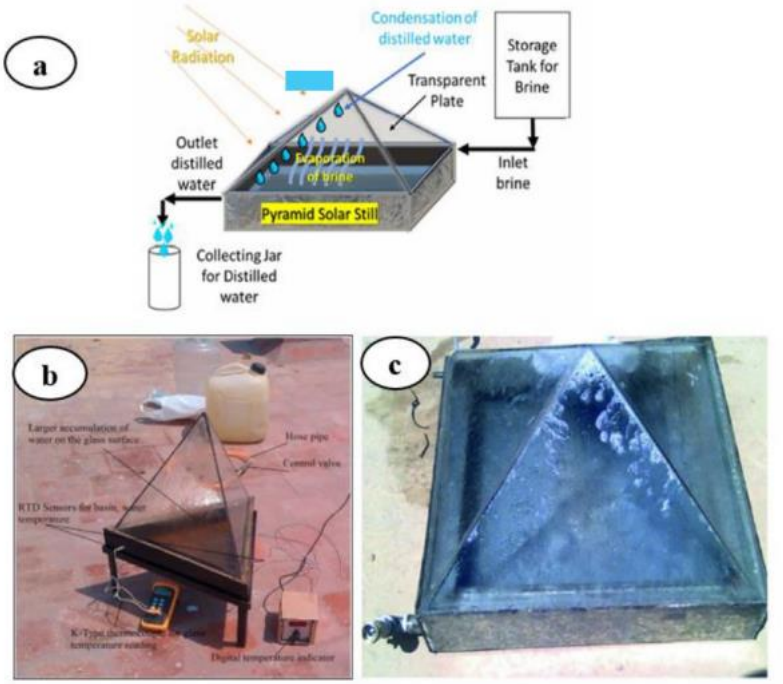
Fig.4 Rectangular and cylindrical perforated fins

i. Techniques used to improve the performance of the solar still

The effectiveness of a solar still depends on several factors such as its design, operation, and the prevailing meteorological conditions. This research paper aims to review various techniques that have been developed to enhance the performance of solar stills. The paper is divided into different sections covering topics such as energy storage materials, changes in the glass cover inclination, the integration of solar collectors, use of external reflectors, sun tracking systems, better basin liner materials, vacuum techniques, and other innovative approaches..

ii. Energy storage materials.

Solar energy is a promising alternative energy option, as it is abundant and safe. However, it is intermittent by nature, as it is not available at night and its total value depends on the meteorological conditions of the location. Therefore, it presents an unsteady energy resource. To address this, thermal energy storage is necessary to save the available solar energy during periods of no load or excessive energy and to make up for the shortage of energy when the load requires it.



(a) Conventional pyramid type solar still **(b)** Triangular pyramid solar still **(c)** Square pyramid solar still.

Fig.4

a) A conventional pyramid solar still is a type of solar still where the top cover is shaped like a pyramid. There are two main shapes of covers and basins available for pyramid solar stills: triangular pyramid and square pyramid. Pyramid solar stills have several advantages over conventional single slope solar stills.
b) The analysis of a solar still system that combines a triangular pyramid solar still with an inclined solar still with baffles. The amount of water in the basin affects the performance of the solar still. By integrating the triangular pyramid solar still with the inclined solar still with baffles, the yield of the system can be increased.
c) Conducted analytical study on solar still having square pyramid shaped top cover. Thermal and economic comparisons between two solar still configurations: the pyramid and the single slop have been carried out and the daily total yield by each still basin was recorded.

A similar attempt was made by Yazan Taamneh et al. (2012) [10] but they had changed the location of fan. They have put fan on one side of pyramid shaped top glass cover as in Fig.8 and recorded daily output was 2.99 l per day (25% higher than solar still with free convection) for forced convective heat transfer in solar still with fan.

III. CONCLUSION

This work reviews the studies and developments of solar stills. Solar stills are categorized into six sorts based on design guidelines. Installing reflectors and solar collectors are more practical in places where solar radiation is weak and the ambient temperature is relatively low. Increasing free surface area, recovering vapor latent heat, installing a heat storage system and enhancing condensation are more suitable for places where solar radiation is relatively strong.

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