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# Single and Four Sloped Solar Still- A Comparative Study

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**ABSTRACT:** Solar stills are a sustainable and cost-effective method for desalination, leveraging solar energy to purify water. This study explores the efficiency and performance of two distinct solar still designs: the single slope and the four sloped solar still. Both systems harness solar energy, but their geometric configurations may influence their effectiveness in terms of water distillation. The higher absorber plate, glass plate, and water temperatures were recorded between 12:00 and 13:00 hours in the four sloped solar still. The double inclination solar still embraces 1.8 liters of potable water during the day, superior to the conventional still.

**KEYWORD:** solar still, Thermal performance, water collection.

## I. INTRODUCTION

With the increasing global emphasis on sustainable and renewable energy sources, the energy sector is undergoing a significant transformation. Among these alternatives, solar energy has emerged as a prominent solution due to its ability to reduce environmental impact while catering to the growing energy demands [1]. One promising application of solar energy lies in solar desalination, which offers a practical and eco-friendly approach to address the critical issue of water scarcity—especially in arid and semi-arid regions with limited access to freshwater resources [2].

Within the spectrum of solar desalination technologies, basin-type solar stills have gained attention for their simplicity, cost-effectiveness, and ability to harness solar energy for water purification [3]. These systems operate on a basic yet effective principle: saline or impure water is heated by solar radiation, leading to evaporation, and the resulting vapor condenses on a cooler surface to yield distilled water [4]. Over the years, researchers have focused on enhancing the efficiency of these systems through various design modifications, material selections, and operational improvements.

Numerous studies have proposed innovative enhancements to traditional solar still designs. Ensafisoroor et al. introduced stepped basins with sponges, which significantly improved water productivity [5]. Hansen et al. explored the use of flat, grooved, and finned absorber plates in inclined stills to recover waste heat and increase efficiency [6]. Goshayeshi and Safaei investigated the influence of glass cover inclination angles (ranging from 25° to 35°) on stepped stills, recommending an optimal angle of 32.5° for enhanced output [7]. Omara et al. developed a pyramid-shaped still using convex cylinders and nanocomposite dish absorbers to maximize productivity [8], while Ahamed et al. integrated phase change material (PCM)-encapsulated fins to improve thermal performance [9]. Similarly, Kabeel et al. reported better efficiency using v-corrugated absorber plates in tubular stills and supported their experimental findings with a detailed mathematical model [10]. Additionally, Hameed et al. conducted a numerical analysis using COMSOL software, confirming strong agreement between simulation and experimental results for single basin solar stills [11]. Jobrane et al. provided a comprehensive review in 2021 on geometrical variations, wick arrangements, and integrated heating systems in wick-type solar stills, underscoring the evolving design trends [12]. These advancements have largely focused on optimizing absorber surfaces, condensation techniques, and geometric configurations, alongside assessing the impact of material properties and climatic conditions such as solar radiation [14, 15], ambient temperature [16], and wind speed [17]. Despite substantial progress, a clear gap remains in the systematic comparison and performance evaluation of Four Slope solar stills, which offer potential advantages in condensate collection and thermal efficiency.



In light of this, the present study aims to design, fabricate, and evaluate two types of solar stills—a conventional single-slope solar still and a four sloped solar still—under identical operating conditions. The performance metrics are compared to better understand the benefits and limitations of each design, thereby contributing to the development of more efficient solar desalination systems.

## II. EXPERIMENTAL SETUP

The experimental setup for the single slope solar still was designed to optimize the distillation process while ensuring efficient solar energy capture. The dimensions of the still were meticulously chosen, measuring 1 meter in length, 1 meter in breadth, and 1 meter in height. The still is inclined at an angle of 30 degrees, which enhances solar radiation absorption and facilitates the condensation of vapor on the glass surface.

The four sloped solar still was designed to enhance the efficiency of water distillation through its innovative geometry. This setup features two sloped surfaces that create a dual condensation area, maximizing the collection of distilled water. The dimensions of the double slope solar still are 73cm in length, 69cm in breadth, and 41cm in height, while maintaining the same 45-degree angle for optimal solar exposure.



*Fig. 1 SINGLE SLOPE SOLAR STILL*



**FIG. 2: FOUR SLOPE SOLAR STILL**

The entire structure was constructed with mild steel (MS), ensuring durability and stability while withstanding outdoor conditions. The absorber plate, a critical component of the still, is painted with dull blackboard paint to maximize solar energy absorption. This choice of paint enhances the heat retention capabilities of the absorber plate, significantly increasing the internal temperature and promoting efficient evaporation of water.

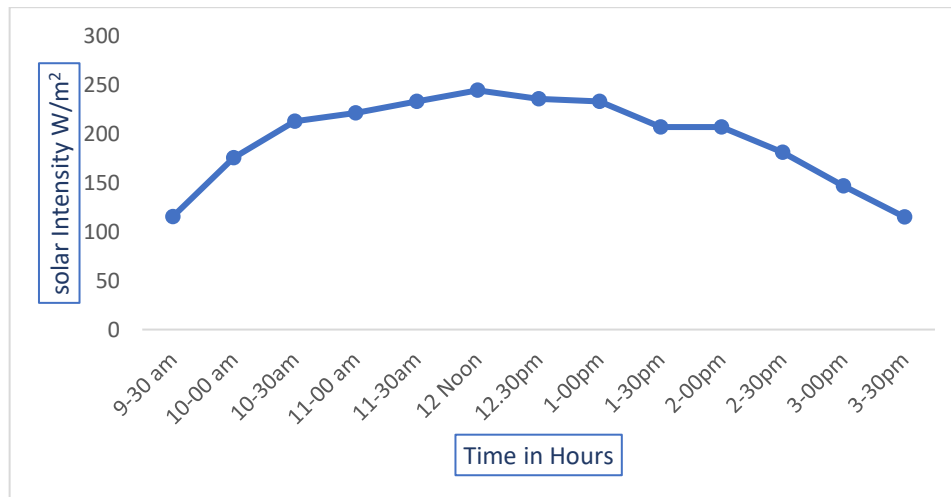
The cover of the still consists of 5 mm thick plain glass, chosen for its transparency and durability, allowing optimal sunlight penetration while minimizing heat loss. Additionally, the entire setup is covered with thermomould to further reduce heat energy loss, ensuring maximum efficiency in the distillation process.

To monitor the performance of the solar still, readings were taken over a time period from 9:30 AM to 3:30 PM for three consecutive days. This timeframe was chosen to capture the peak solar radiation hours, allowing for a comprehensive assessment of the still's efficiency. The thermomould wires were strategically placed in two locations within the still to provide an average temperature reading, ensuring accurate data collection for performance analysis. The evaporated water vapor condenses on the glass surface and flows down to a collection trough, where the quantity of distilled water is measured. By averaging the readings from both days, we aim to obtain a reliable performance metric for the solar still, contributing valuable insights into the optimization of solar distillation methods.

### III. RESULTS AND DISCUSSION

#### 3.1 Variation in Solar Intensity over Time

Figure 3 shows the variation in Solar intensity over the day time which varies throughout the day due to changes in the sun's position and atmospheric conditions. Its peak at the noon ( $207.4 \text{ W/m}^2$ ), and decreases as the sun descends. This fluctuation impacts the efficiency of solar stills in water distillation processes.



**Fig. 3 Variation in Solar Intensity Over Time**

#### 3.2 Variation in absorber Basin temperature

Fig. 4 shows the variation in absorber Basin temperature over the day. The absorber temperature increase after 9.30 a.m. and reach the maximum between 12.00 noon and 1.30 pm. However, it decreases in afternoon. In Four slope Solar Still, the maximum absorber plate temperature reaches a maximum temperature of around  $66.4^\circ\text{C}$  and  $65.1^\circ\text{C}$  in double inclined and conventional (single slope) solar still between 12 noon to 1.30 PM where the solar intensity is the highest.

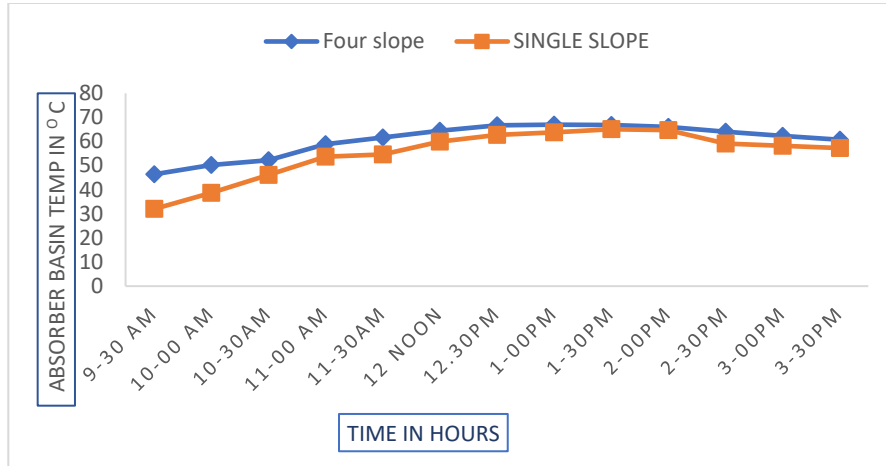


Fig. 4 Variation in Absorber Basin Temperature Over Time

### 3.3: Variation in Water Temperature over Time

Figure: 5 shows that the variation in water temperature in the attempted solar still configurations. While single slope stills reach a temperature of around 60°C, the Four slope solar stills exhibit better water temperature due to their enhanced condensation surface area. This phenomenon is consistent with the studies of Harisivasankaran et al [18].

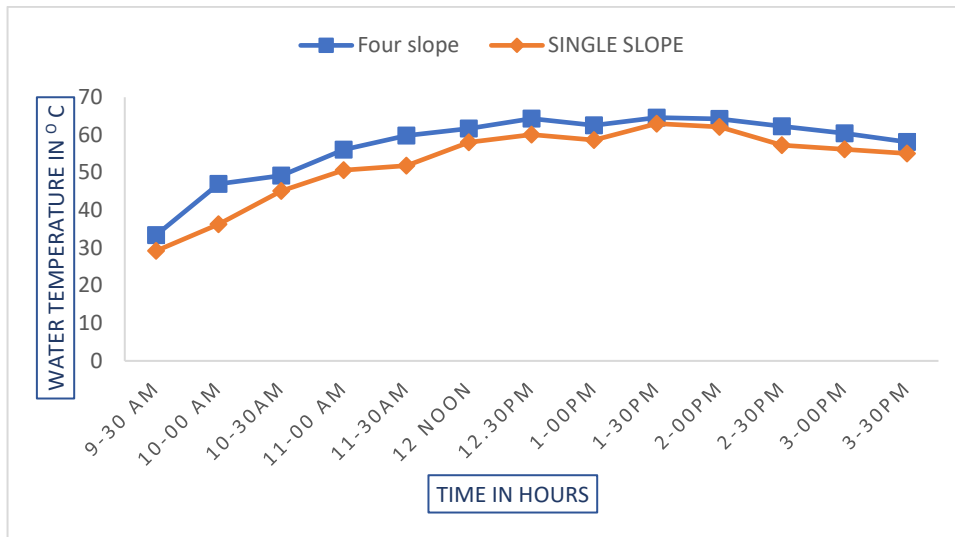


Fig. 5 : Variation in Water Temperature

### 3.4: Variation in Glass Temperature Over Time

The glass plate temperature recorded during the day time is shown in Fig.6. The maximum temperature (Fig. 6) of single slope solar still is 4% higher than the Four Slope solar still. The increase is due to its exposure to the ambient air and the evaporative cooling effect. The temperature gradient between the water and the glass plate is crucial for maximizing the condensation rate.

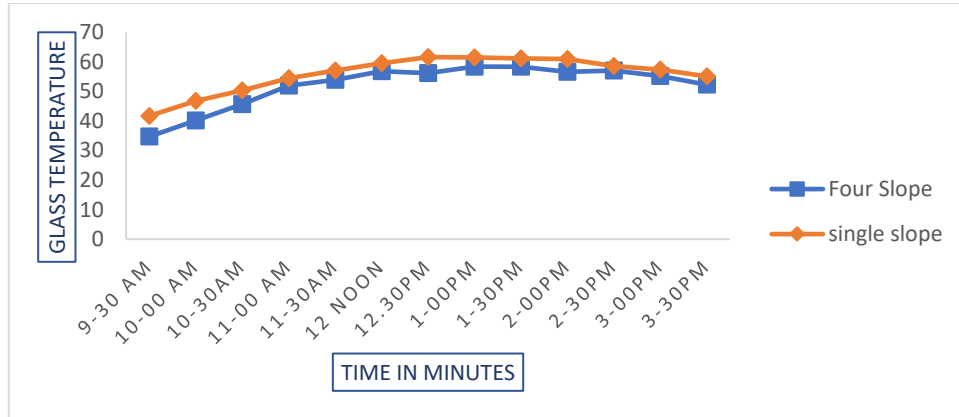


Fig. 6 : Variation in Glass Plate Temperature Over Time

### 3.6: Variation in Water collection during a day time

The double sloped solar still collected 1847 ml of water, outperforming the single slope solar still, which yielded 1420 ml over the same period (Fig.8). This significant difference highlights the efficiency of the Four Slope design in solar desalination applications. These findings suggest potential for optimizing solar still configurations to enhance water production.

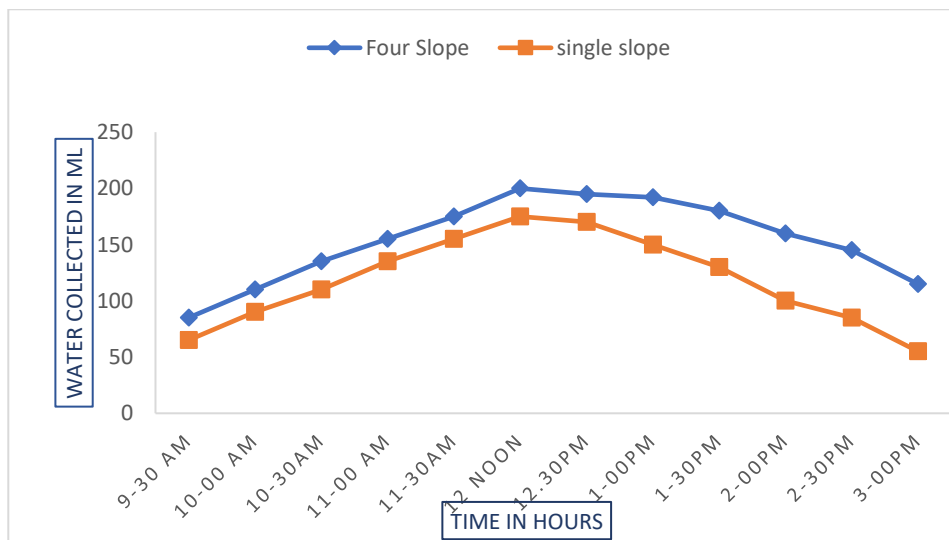


Fig.7: Water Collected During Day Time

## IV. CONCLUSIONS

The salient conclusions from this experimental study on the fabrication and testing of solar still configurations are as follows:

1. The Four Slope solar still improves the absorber plate, water, and glass temperatures.
2. The enhancement in contact area increases the heat transfer area, which enhances the heat retention and improves the rate of condensation.
3. The water collected in the Four Slope solar still is 30% higher than the conventional solar still.

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