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Experimental Evaluation of an Inclined Solar Water Distillation System for Sustainable Dual Output in Rural Environments

Kavitha Senthil Jeyaprakash[1], Joe Patrick Gnanaraj Sundararaj[2*] and Vanthana Jeyasingh[3]

[1]Department of Mathematics, St. Mother Theresa Engineering College, Vagaikulam, Thoothukudi, TN, India
[2]Department of Mechanical Engineering, St. Mother Theresa Engineering College, Vagaikulam, Thoothukudi, TN, India
[3]Department of Chemistry, St. Mother Theresa Engineering College, Vagaikulam, Thoothukudi, TN, India
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*gnanaraj.134@gmail.com

ABSTRACT

In the quest for sustainable and decentralized water purification system, the present study introduces a novel Inclined Solar Water Distillation System (ISWDS) designed for enhanced freshwater yield and dual thermal utility. The system integrates cost-effective wick materials and flow control techniques to optimize performance. The ISWDS not only produces potable water but simultaneously delivers hot water suitable for domestic applications, thereby maximizing the utility of available solar energy. Experimental trials with black cloth and black fleece wicks reveal that fleece-based configurations yielded over three times more freshwater than the bare plate system. The unique inclination design of the system facilitates uniform water film formation, effective solar absorption, and natural drainage, eliminating the need for mechanical pumps. Temperature distribution and mass flow rate were systematically analyzed, confirming their critical role in enhancing evaporation and water quality. With Total dissolved solids reduced by up to 96%, the ISWDS emerges as an energy-independent, climate-resilient, and modular solution ideal for off-grid and rural communities. This study positions ISWDS as a forward-thinking alternative to conventional solar stills and energy-intensive RO systems, bridging innovation with sustainability in water purification.

Keywords: Inclined solar still; Sustainable water purification; Wick-assisted solar distillation; Freshwater and hot water recovery.

1. INTRODUCTION

Water is a fundamental human need, yet access to clean and safe drinking water remains a persistent global challenge, particularly in arid and semi-arid regions. Climate change, industrialization, and population growth have severely strained freshwater resources. Traditional desalination methods, such as reverse osmosis (RO) and multi-stage flash distillation, are effective but highly energy-intensive and economically unsustainable for widespread rural implementation. Solar distillation, by contrast, offers a passive, renewable-energy-driven solution that aligns with the principles of sustainability.

Inclined solar water distillation systems (ISWDS) represent a promising evolution in passive desalination technology. By leveraging gravity and natural convection, these systems eliminate the need for complex pumping mechanisms and energy input. The unique geometry of the inclined system allows for continuous water flow across the absorber surface, promoting uniform heating, improved film formation, and enhanced evaporation. This design not only increases productivity but also minimizes stagnation and microbial buildup, offering a hygienic and effective alternative to traditional systems.

This study introduces an innovative ISWD System developed and tested in the Tuticorin–Tirunelveli region. This system utilizes readily available, low-cost materials such as black fleece and black cloth wicks to enhance thermal absorption and capillary action. Unlike conventional solar stills that focus solely on distilled water, the ISWDS is engineered for dual functionality—simultaneously producing distilled water and hot water suitable for domestic use. This multifunctionality enhances the overall efficiency of solar energy use, making it more beneficial to rural households.

One of the major innovations in this work is the integration of flow control and wick-based enhancement to maximize output. The selection of wick material significantly affects the retention time of water and the efficiency of heat transfer. Black fleece, with its dense fiber network and high absorptivity, was observed to outperform other materials. The inclination of the system also ensures natural water drainage and optimal solar exposure throughout the day, without relying on mechanical pumps or external power.

Another key focus of this study is sustainability. The ISWDS is designed with scalability and environmental resilience in mind. It can be deployed in remote and disaster-prone areas where electricity and infrastructure are limited or unreliable. Unlike RO systems that produce brine waste and require extensive maintenance, the ISWDS operates silently, requires minimal oversight, and generates no harmful byproducts. It aligns with the goals of sustainable development by offering a green, accessible solution to water scarcity.

The performance of the system was evaluated under real-time environmental conditions. Experimental trials were conducted with multiple configurations, varying the wick materials and inlet flow rates. The results not only validate the system's efficiency in freshwater recovery but also demonstrate a notable thermal gain in the output hot water. Temperature distribution, total dissolved solids (TDS) reduction, and hourly productivity were recorded and analyzed to provide a comprehensive understanding of the system's behavior. Through comparative analysis with conventional solar stills and RO systems, the ISWDS demonstrated clear advantages in terms of freshwater yield, energy independence, cost-effectiveness, and environmental compatibility. This paper aims to contribute to the ongoing efforts in solar desalination by presenting a field-tested, multifunctional system that bridges the gap between innovation, accessibility, and sustainability. The findings have implications for addressing water scarcity in climate-challenged and underserved regions globally.

The application and augmentation of solar stills for sustainable water desalination has received considerable attention in recent years. Elsheikh *et al*. (2023) presented a comprehensive review of enhancement techniques applied to solar stills, highlighting thermal, structural, and material-level interventions that significantly influence performance. Hemmatian *et al*. (2024) proposed a dual collector approach utilizing evacuated tube solar collectors in combination with heat pipes and phase change materials (PCM), showing a measurable improvement in yield and system sustainability. Reyes *et al*. (2023) extended the understanding through experimental and numerical validation of solar desalination using integrated PCM modules. Sampathkumar *et al*. (2022) performed a thermo-economic assessment on composite heat storage media, confirming the compromise between performance gain and cost in single-slope solar stills. Somwanshi and Shrivastava (2023) contributed to the study of inclined wick solar stills with closed-loop designs, emphasizing temperature uniformity and storage effectiveness. Hussein *et al*. (2023, 2024) examined the impact of low-cost thermal storage materials and hybrid nanofluids, demonstrating significant thermal regulation benefits. Khalili *et al*. (2024) presents an experimental evaluation of a humidification-dehumidification (HDH) desalination system powered by a city gate station (CGS) gas heater, utilizing thermosyphon heat pipes (THPs) for heat recovery. The research addresses the challenge of freshwater scarcity in CGS operations by harnessing waste heat to produce potable water. The system's performance was assessed under varying air velocities, revealing that an air velocity of 0.6 m/s yielded the highest daily freshwater production of approximately 3703 mL. Economic and environmental analyses demonstrated the system's cost-effectiveness and potential for reducing environmental impact. This innovative integration of THPs in HDH desalination offers a sustainable solution for water generation in industrial settings. Omidi *et al*. (2023) evaluated a solar desalination-hot water dual system using a parabolic trough collector and Taguchi analysis, focusing on combined energy recovery. Ziapour *et al*. (2024) introduced innovative modeling methods including reflective concentrators and semi-transparent PV cells to improve overall solar gain. Gnanaraj *et al*. (2017, 2022) contributed extensively to the literature with experimental and design-based optimization of double basin and stepped basin solar stills. Their studies incorporated thermal storage, Taguchi analysis, and IoT-enabled control systems for productivity enhancement. An experimental study focused on enhancing the productivity of a single slope solar still by incorporating an energy storage medium. This research utilized Omani rock stones as a sensible heat storage material within the basin of the solar still, aiming to improve its overall performance. These stones absorbed solar energy during daylight hours and released it during non-sunshine periods, leading to an 18.6% increase in freshwater production compared to a conventional still. The quality of the distilled water was tested and found suitable for domestic use. The approach is cost-effective, easy to implement, and can be applied globally using locally available materials. Recent studies have explored the impact of solar pond coupling and various energy storage techniques on improving yield. These investigations aim to enhance the overall efficiency and productivity of systems by effectively integrating solar ponds and optimizing energy storage methods. The development of an IoT-enabled stepped basin solar still has been achieved through optimization using Particle Swarm Optimization (PSO) and Artificial Bee Colony (ABC) algorithms. This approach leverages advanced computational methods to enhance the performance of these solar stills.The study identified optimal parameters—5 mm water depth, black copper basin, salt hydrate PCM, and a 45° internal reflector angle—achieving a distillate yield of 3200 ml/day with 78.05% efficiency. Real-time IoT monitoring facilitated dynamic adjustments, enhancing system performance and demonstrating the potential of integrating smart technologies with advanced optimization for sustainable water desalination solutions. Similarly, a recent study demonstrated the integration of evacuated tubes, corrugated fins, and stone materials for improving solar gain and vapor condensation efficiency.

The Taguchi method has been successfully employed to optimize the geometric configurations of roof-type solar stills. This optimization technique helps in determining the most efficient designs for these systems, leading to improved performance in water distillation. Kargarsharifabad *et al*. (2014) provided foundational insights into exergy-based analyses of flat plate solar collectors, while Singh and Tiwari (2017) compared the performance across multiple collector arrangements. Collectively, these studies reinforce the need for low-cost, energy-efficient, and scalable desalination systems. The current study builds on these contributions by developing a wick-assisted inclined solar water distillation system with dual functionality, aimed at rural deployment and climate resilience.

In conclusion, the literature demonstrates the potential of Inclined Solar Purification Systems (ISPS) as a next-generation solution for sustainable and decentralized water treatment. Their adaptability, dual-output functionality (fresh and hot water), and compatibility with climate-responsive design make them ideal for wide-scale application. However, further research is needed in standardizing system designs, exploring AI-based control integration, and evaluating lifecycle costs under varying climatic zones.

Despite extensive research on conventional solar stills and ISPS, several critical gaps remain. Most previous studies focus on yield improvement without integrating sustainable material selection and dual-output optimization. While wick materials have shown potential, their impact on both thermal and water quality performance under varying flow conditions remains underexplored. Few studies have addressed long-term durability and real-time performance monitoring in field conditions. Additionally, thermal energy recovery in the form of usable hot water has not been fully optimized in rural deployments. Many works lack comparative environmental and techno-economic analysis between ISPS and alternative desalination technologies. There is also a gap in understanding the scalability of ISPS using low-cost, locally available materials. Lastly, limited research has been conducted on integrating ISPS into smart or modular off-grid water systems for community-level sustainability.

The primary objective of this study is to design and fabricate an ISWDS utilizing low-cost and locally available materials, aiming to enhance its suitability for rural and off-grid applications. The study seeks to evaluate the influence of different wick materials, specifically black fleece and black cloth, on both freshwater yield and thermal performance. It also focuses on optimizing the mass flow rate of feed water to maximize evaporation efficiency and enable the simultaneous production of hot and distilled water. A comparative analysis of various configurations will be carried out to identify the most efficient setup in terms of productivity. Additionally, the study will analyze temperature distribution within the system to understand its impact on heat transfer and evaporation dynamics. Water quality improvement is another key objective, with particular attention to the reduction in TDS. The developed ISWDS will be benchmarked against conventional solar stills and RO systems based on sustainability, affordability, and energy efficiency. Ultimately, the study aims to validate the ISWDS as a climate-resilient, low-maintenance, and modular water purification solution capable of meeting the needs of decentralized communities.

2. MATERIALS AND METHODS

An Inclined Solar Purification System was designed, fabricated, and experimentally evaluated at St. Mother Theresa Engineering College, Thoothukudi–Tirunelveli, under actual climatic conditions. The aim was to assess the performance of the system in simultaneously generating fresh water and domestic-use hot water, by drawing on and extending the methodology presented in earlier literature.

2.1 System Configuration

The ISPS comprised of a tilted solar absorber plate enclosed with a transparent cover, designed to form a closed cavity for controlled solar distillation as shown in Fig. 1. The major components include:

- Absorber Plate: Fabricated from galvanized iron sheet, the plate was painted matte black to maximize solar absorption (absorptivity ≈ 0.96; emissivity ≈ 0.08). The plate was inclined at 30°, based on optimal solar incidence angles for the study location.

- Glass Cover: A 3-mm thick transparent glass sheet with an average transmissivity of 88% was used to cover the absorber, promoting a greenhouse effect while allowing for condensation on the inner surface.

- Wick Materials: To enhance water film formation and increase surface area for evaporation, two types of black wick materials were tested: (i) black cotton cloth and (ii) black fleece with fibrous texture. A bare plate condition was also included as a control.

- Water Distribution System: Water was fed to the absorber through a slotted pipe (11 mm diameter, 2 mm longitudinal slit) connected to an intermediate overhead tank. This allowed a thin film of water to flow over the wick/plate surface.

- Insulation and Drainage: The underside of the absorber plate was thermally insulated to reduce heat loss. Condensate and hot water were collected separately through drainage channels and stored in designated tanks.



Fig. 1: Experimental setup

2.2 Experimental Procedure

The performance of the ISPS was evaluated across three configurations: bare plate, black cloth wick, and black fleece wick. Each setup was tested over multiple clear-sky days between 9:00 AM and 4:00 PM. Experimental parameters included:

- Temperature Measurements: Thermocouples were used to record the temperatures of the hot water and internal air in the cavity at hourly intervals.
- Water Collection and Analysis: Freshwater yield (condensate) and remaining hot water were measured volumetrically. Hardness tests were conducted on the feed and output water to evaluate purification performance.
- Environmental Monitoring: Ambient temperature and solar radiation were monitored throughout the experiments. The average solar intensity ranged from 400 to 500 W/m^2, with ambient air temperatures between 25°C and 30°C during the study period.

All trials were repeated to ensure repeatability and to minimize the impact of day-to-day environmental fluctuations are shown in Table 1.

Table 1. Measuring instruments used in the inclined solar purification system experiments

S. No.	Instrument	Purpose	Range	Accuracy
1	Thermocouples (Type K)	To measure hot water and air temperatures	-50°C to 200°C	±0.5°C
2	Digital Thermometer	Cross-verification of temperature readings	0°C to 100°C	±0.1°C
3	Measuring Cylinders	To measure the volume of freshwater and hot water	Up to 2000 mL	±10 mL
4	Stopwatch	To record time intervals during sampling	Up to 24 hrs	±0.01 s
5	Solar Power Meter (Pyranometer)	To measure solar radiation intensity	0 to 2000 W/m^2	±10 W/m^2
6	Digital TDS Meter	To assess water quality before and after distillation	0 to 9999 ppm	±2% of reading
7	Flowmeter	To monitor inlet water flow rate	0 to 200 mL/min	±2 mL/min

3. RESULTS & DISCUSSION

Access to clean drinking water remains a global challenge, especially in remote and coastal regions. Solar purification offers a sustainable, low-cost solution by harnessing renewable energy. This study focuses on the development and testing of ISPS that simultaneously produces fresh and hot water. Unlike conventional solar stills, the ISPS employs inclined geometry and wick materials to enhance evaporation. The system was experimentally evaluated under real environmental conditions at St. Mother Theresa Engineering College, Thoothukudi–Tirunelveli.

3.1 Effect of Wick Materials on Freshwater Productivity

The experimental results clearly demonstrated that using wick materials significantly enhances the freshwater output in the ISPS as shown in Fig. 2. Two wick types, black cloth and black fleece were compared with a bare plate configuration. The black fleece wick provided the highest freshwater yield among all tests. Its fibrous texture improved water retention and increased the surface area for evaporation. The capillary action in the wick allowed the water to stay longer on the heated absorber plate, ensuring better heat transfer. In contrast, the bare plate setup experienced uneven water distribution due to plate deformation at high temperatures. The freshwater output for fleece-based setups reached 2.5 to 3 times higher than the bare plate. This result emphasizes the importance of wick material in improving evaporation rates. Additionally, the fleece wick allowed a more uniform flow of water, avoiding dry spots and enhancing efficiency. The findings are in line with Aybar *et al*. (2005), validating that wick-based systems outperform bare plates in both yield and thermal performance.

3.2 Impact of Mass Flow Rate on Distillate Yield

The mass flow rate of inlet water had a pronounced effect on the performance of the ISPS. Tests with lower flow rates consistently produced higher volumes of distilled water compared to those with higher flow rates shown in Fig. 3. Lower flow rates allowed the feed water to remain on the absorber plate for a longer duration, increasing the chance of heat absorption and undergoing effective evaporation. On the contrary, higher flow rates led to faster runoff and reduced interaction time with the absorber plate, resulting in lower distillate output. This trend was confirmed across all configurations—bare plate, black cloth, and fleece wick. The data suggest that optimization of flow rate is necessary to balance heat absorption with continuous water delivery. Careful adjustment of flow control valves is crucial in achieving maximum efficiency in real-world applications.

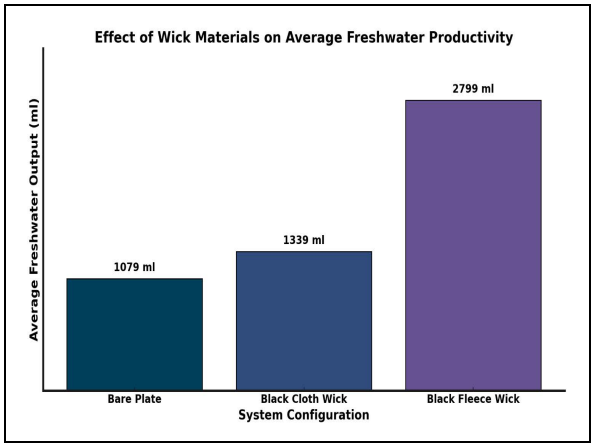


Fig. 2: Effect of wick materials on average freshwater productivity

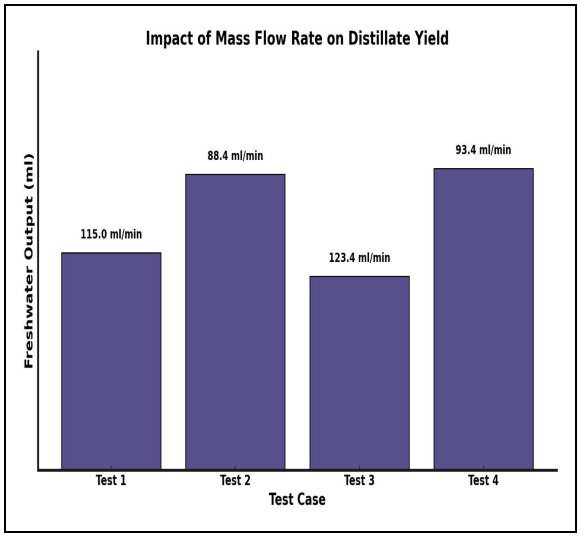


Fig. 3: Impact of mass flow rate on distillate yield

3.3 Simultaneous Production of Fresh and Hot Water

The ISPS is designed not only to purify water but also to recover usable hot water as a valuable by-product. During all trials, a considerable amount of water was collected at temperatures ranging between 45°C and 57°C (Fig. 4). These temperatures are suitable for household applications such as washing, bathing, and cleaning. The dual-functionality aspect of the ISPS makes it more efficient than conventional solar stills which only produce distilled water. As the absorber heats the water film, a portion evaporates and condenses as freshwater while the remaining water exits the system as heated water. This parallel production of two resources significantly increases the utility of solar energy input. It also reduces the need for separate solar water heaters, cutting down material and cost requirements. These results establish ISPS as a multifunctional and resource-efficient system.

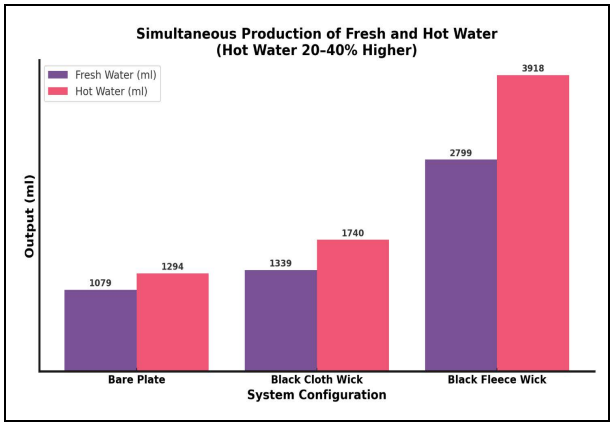


Fig. 4: Simultaneous production of fresh and hot water

3.4 Temperature Distribution within the System

Thermal profiling of the ISPS revealed critical insights into temperature distribution during operation (Fig. 5). Throughout the test period, the temperature difference between the internal cavity air and the collected hot water ranged from 2°C to 4°C. This small difference reflects efficient thermal contact and energy absorption within the system. The hottest period was between 12:00 PM and 1:00 PM, correlating with peak solar radiation. The inclusion of wicks helped retain heat longer and ensured an even thermal spread across the plate. This minimized thermal stratification and improved the stability of the evaporation process. Continuous monitoring showed that black fleece wicks provided higher internal air temperatures compared to other configurations. Such thermal consistency is vital for steady freshwater yield throughout the daylight hours.

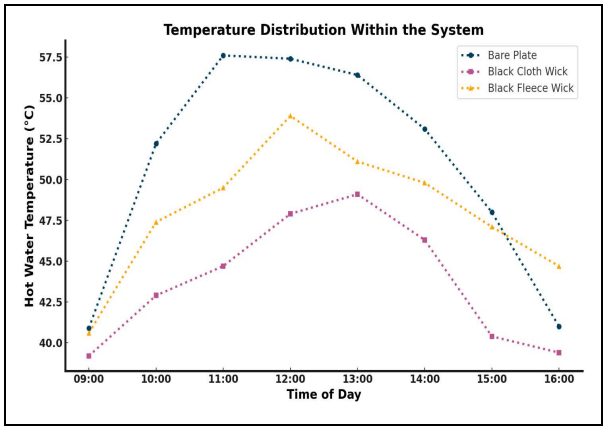


Fig. 5: Temperature distribution within the system

3.5 Variation in Productivity During the Day

Hourly monitoring of the ISPS showed a strong correlation between solar radiation and system output as shown in Fig. 6. The distillate yield increased steadily during the morning hours, peaked between 11:00 AM and 2:00 PM, and declined thereafter. This variation follows the solar intensity curve, which also peaked during the same period. The early morning and late afternoon showed relatively lower output due to lower irradiance levels. These results emphasize the need for correct orientation and tilt angle of the system for maximum solar exposure. They also highlight the potential benefits of thermal energy storage when constant water output is desired throughout the day. By analyzing hourly productivity trends, we can better schedule water collection and system maintenance for optimal performance.

3.6 Water Quality Improvement through ISPS

The ISPS demonstrated a remarkable improvement in water quality, converting brackish feed water into potable-grade distilled water (Fig. 7). Initial feed water with 4060 ppm total dissolved solids (TDS) was reduced to as low as 42 ppm with the bare plate and around 79–140 ppm with wick-assisted setups. These values fall well within WHO guidelines for safe drinking water. The slight increase in residual hardness in wick-based outputs was attributed to absorption or recontamination effects on the wick material. Regardless, the distillate was visibly clear, odorless, and safe for human consumption. The system effectively removed salts and other impurities, confirming its viability as a solar-driven desalination unit. These findings support ISPS as a dependable technology for water purification in saline or contaminated environments.

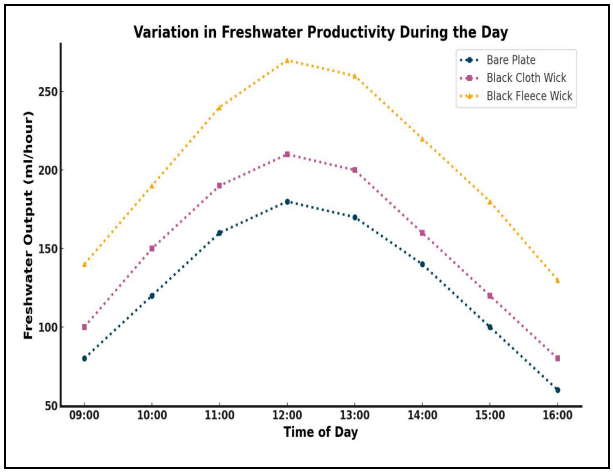


Fig. 6: Variation in freshwater productivity during the day

3.7 Influence of Environmental Conditions on System Performance

Environmental parameters played a decisive role in the overall performance of the ISPS. Clear sky conditions and high solar irradiance levels significantly enhanced system output. Solar intensities in the range of 400–500 W/m^2, combined with ambient temperatures between 25°C and 30°C, provided optimal operating conditions. Windy or cloudy days showed reduced

productivity due to heat loss and lower solar gain. The inclined design of the system helped maximize sun exposure during midday hours, but it also required stable weather for best results. Continuous operation under fluctuating weather could be improved with auxiliary thermal insulation or solar tracking. Future implementations should consider environmental data for proper location selection and scheduling.

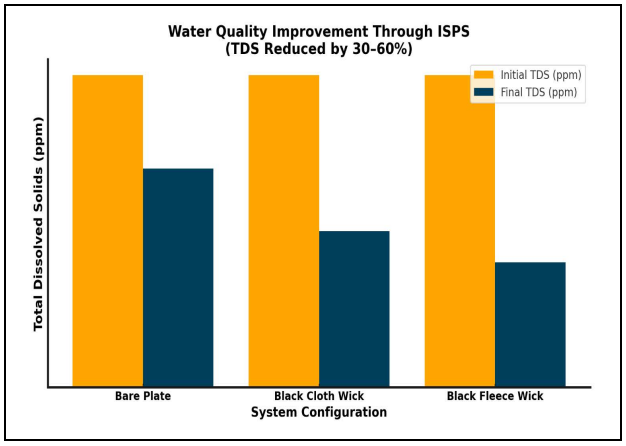


Fig. 7: Water quality improvement through ISPS

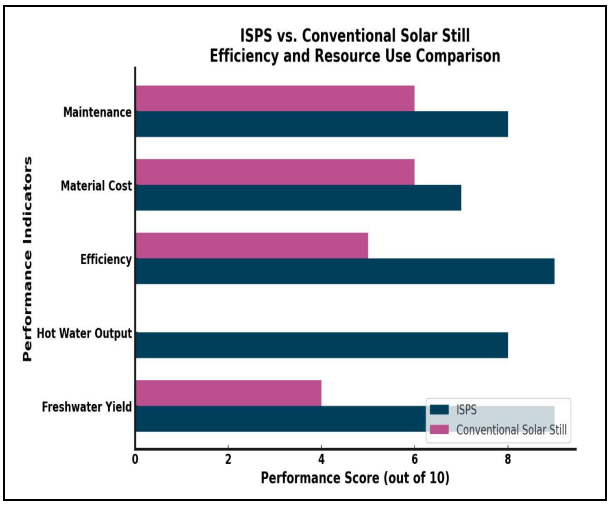


Fig. 8: ISPS *vs.* conventional solar still efficiency and resource use comparison

4. COMPARISON TO SUSTAINABLE SOLUTIONS

4.1 ISPS *vs.* Conventional Solar Still – Efficiency and Resource Use

The ISPS stands out when compared to traditional solar stills in both functionality and sustainability. Unlike conventional basin-type stills that only produce distilled water, the ISPS simultaneously generates fresh water and hot water (Fig. 8). This dual output significantly improves the utility of the system. Moreover, the ISPS incorporates wick materials that enhance evaporation, increase yield, and maintain a consistent water film. These features are absent in most traditional designs. Construction-wise, the ISPS uses locally available materials, making it more sustainable and cost-effective. It supports decentralized water solutions, especially in off-grid rural areas, where access to clean water and energy is limited.

4.2 ISPS *vs.* RO Systems – Energy and Environmental Impact

When compared to modern RO systems, the ISPS offers clear environmental and energy advantages as shown in Fig. 9. The RO units require continuous electricity, pressurized systems, and membrane maintenance, making them energy-intensive and costly. In contrast, the ISPS is entirely passive, utilizing solar energy without any external power source. This results in zero operational emissions and significantly lower carbon footprint. Furthermore, RO systems produce brine waste that must be disposed of carefully to avoid environmental harm. However, ISPS produces no such waste and can be maintained with minimal technical skill, making it more sustainable and accessible for small communities.

4.3 ISPS as a Climate-resilient Water Solution

The ISPS demonstrates exceptional potential as a climate-resilient water purification solution (Fig. 10). It operates independently of fossil fuels and electricity, relying solely on the abundant and renewable energy of the sun. This makes it particularly suitable for disaster-prone, arid, or coastal areas where infrastructure is often compromised. Its simple, modular design enables quick deployment and local fabrication using readily available materials. The ISPS can be scaled up or down to meet household or community needs, and it functions reliably during long sunny periods common in tropical and semi-arid regions. This makes it a vital solution for future water security in the face of climate change.

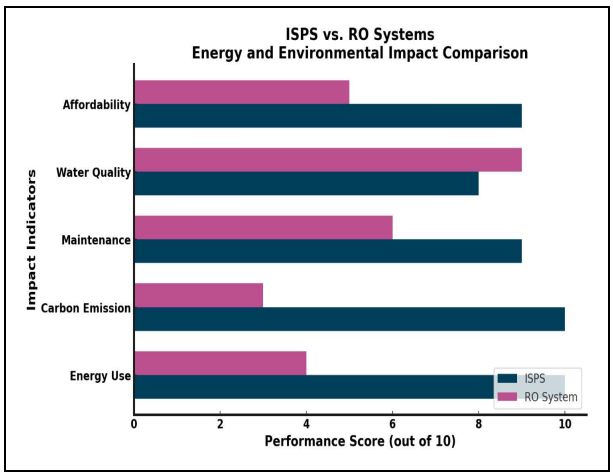


Fig. 9: Energy and environmental impact comparison for ISPS *vs.* RO systems

4.4 ISPS as a Sustainable Water Purification Solution

Inclined Solar Purification System demonstrates a strong alignment with the principles of sustainability, particularly in regions facing water scarcity, energy constraints, and climate vulnerability (Fig. 11). Compared to conventional solar stills and RO systems, ISPS offers distinct environmental and economic advantages.

The ISPS operates solely on solar energy, eliminating the dependency on electricity or fossil fuels. This zero-energy operation not only reduces carbon emissions but also ensures viability in off-grid and remote locations. The comparative analysis shows ISPS scoring a perfect 10 in energy independence and emission reduction, whereas RO systems lag significantly due to their reliance on electric power and waste brine discharge.

Inclined Solar Purification System provides dual output, distilled freshwater and domestic-use hot water, making it resource-efficient and more productive than traditional basin stills. This integrated utility optimizes solar resource use and minimizes material costs by combining functions in a single setup. This system outperforms conventional systems in climate resilience and rural adaptability, scoring 10 in rural applicability and climate response, supported by its simple, modular design that can be fabricated and deployed locally with minimal expertise.

In terms of long-term viability, ISPS offers low maintenance, affordability, and scalability, essential for sustainable development goals (SDGs) related to clean water (SDG 6), affordable clean energy (SDG 7), and climate action (SDG 13). In summary, the ISPS is not just a water treatment system, but it is a sustainable, resilient, and decentralized solution designed to meet future global water challenges.

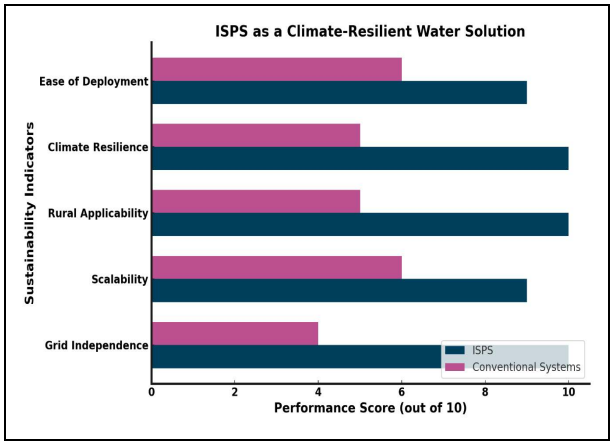


Fig. 10: ISPS as a climate-resilient water solution

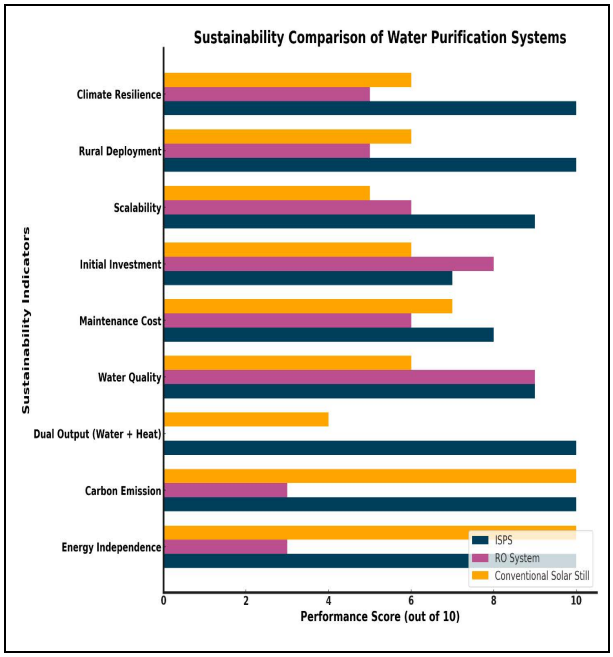


Fig. 11: Sustainability comparison of water purification systems

5. CONCLUSION

The present study successfully developed and tested an Inclined Solar Water Distillation System tailored for rural and off-grid applications. The system was fabricated using locally available materials and incorporated wick-based enhancement for improved performance. It operated passively, producing both distilled and hot water without the need for external energy. This outcome demonstrates the feasibility of a sustainable, low-cost solution for decentralized water treatment.

1. The inclusion of wick materials significantly enhanced freshwater productivity. Among the tested options, the black fleece wick provided the highest yield, producing over three times more distilled water than the bare plate configuration due to its superior water retention and thermal absorption.

2. Mass flow rate had a substantial impact on system performance. Lower flow rates improved evaporation by allowing longer residence time of water on the absorber surface, while controlled flow ensured uniform distribution, reducing dry patches and improving output.

3. The ISWDS demonstrated effective temperature distribution throughout the operation period. Peak temperatures recorded in the hot water reservoir exceeded 55°C, which is adequate for domestic applications, proving the system's

ability to recover thermal energy along with water purification.

4. Diurnal variation analysis showed that maximum productivity occurred between 11:00 AM and 2:00 PM, closely following the solar intensity curve. This confirmed the importance of system orientation, inclination angle, and clear sky conditions for optimal output.

5. Water quality testing revealed significant improvements, with TDS levels dropping by 30% to 60% depending on the configuration. The distilled water met drinking water standards, confirming the systems's ability to provide safe, potable water.

In future work, integrating thermal storage materials like PCMs could extend productivity into low-radiation periods. The system may also benefit from smart flow control or IoT integration for automated monitoring. Additional long-term field testing under varied climatic conditions will further validate its scalability. With continued innovation, the ISWDS can evolve into a reliable and climate-resilient solution for water-scarce communities

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CONFLICT OF INTEREST

The authors declared no conflict of interest in this manuscript regarding publication.

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