IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 3, November 2026
Impact Factor: 8.2

Hybrid Solar-Thermal Water Purifier

Dileep H B[1], Hirelingaiah B D[2], Hithesh H N[3] ,Nandan R[4] ,Tejaswi L N[5]
[1]Assistant. Professor, Dept of Mechanical Engineering
[2,3,4,5]Students, Dept of Mechanical Engineering
Kalpataru Institute of Technology Tiptur, Karnataka

Abstract: *The hybrid system combines solar energy with supplementary thermal energy to maintain the heating process during low sunlight conditions. This helps to improve the operating reliability of the system and supports water purification even when solar radiation is insufficient. The purified water is collected in a separate storage tank for further use. The system can be designed using components such as a solar collector, heating chamber, thermal heating unit, condenser, connecting pipes, and water storage tank.*

The proposed system offers several advantages, including reduced electricity consumption, lower operating costs, environmental protection, and the effective utilization of renewable energy. It also helps reduce dependence on conventional energy sources and makes use of naturally available solar energy. This project is particularly useful in rural areas, villages, remote locations, and places where access to clean drinking water and electricity is limited. The system provides a sustainable approach to water purification and supports the conservation of natural resources. , the Hybrid Solar-Thermal Water Purifier aims to develop a simple, reliable, and cost-effective water purification system that combines solar and thermal energy to produce clean water while reducing environmental impact.

Keywords: Hybrid Solar Energy, Solar Thermal Energy, Water Purification, Solar Collector, Thermal Heating, Evaporation, Condensation, Heat Transfer, Renewable Energy, Clean Drinking Water, Energy Efficiency, Sustainable Technology

I. INTRODUCTION

The working principle of this project is based on evaporation and condensation. Initially, impure water is supplied to the heating chamber. Solar energy is collected and used to heat the water. When the water reaches a suitable temperature, it starts evaporating and changes into water vapour. The vapour is then passed through a condenser, where it is cooled and converted into liquid water. Most dissolved salts, suspended impurities, and non-volatile contaminants remain in the heating chamber. The condensed water is collected in a separate storage tank. The main purpose of this project is to develop an economical, energy-efficient, and eco-friendly water purification system. The hybrid arrangement helps improve the reliability of the purification process and reduces the dependence on electrical energy. It also makes effective use of renewable solar energy.

This system can be useful in rural areas, villages, small households, and remote locations where access to clean drinking water is limited. It can also help reduce environmental pollution and promote the sustainable utilization of natural resources. Hybrid Solar-Thermal Water Purifier provides a simple and sustainable approach to water purification. By combining solar and thermal energy, the project aims to produce purified water at a lower operating cost while supporting environmental protection and energy conservation. The performance of the water purifier depends on various factors such as solar radiation, water temperature, collector efficiency, heat losses, condenser performance, and the quantity of water supplied. Proper insulation of the heating chamber and connecting pipes can reduce heat loss and improve the overall thermal efficiency of the system.

This project focuses on developing a simple and cost-effective water purification system using renewable energy. It also helps students understand the practical applications of heat transfer, solar energy conversion, evaporation,

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 3, November 2026
Impact Factor: 8.2

condensation, and thermal system design. The proposed system can be useful in rural areas, villages, small households, schools, and remote locations where access to clean drinking water and electricity is limited. It may also be used for small-scale water purification applications, depending on its design and production capacity.

II. LITERATURE SURVEY

Active solar water purification systems use solar collectors to absorb solar radiation and transfer heat to the water. This increases the water temperature and improves the evaporation process. These systems can provide better performance than conventional passive solar stills. Hybrid solar water purification systems combine solar energy with additional heating arrangements to maintain the required water temperature. This helps improve the purification process, especially when solar radiation is low. The combination of solar thermal energy and additional heating can also reduce dependence on conventional electrical energy.

Researchers have also studied heat recovery techniques to improve the thermal efficiency of solar water purification systems. These techniques reuse the heat generated during condensation and reduce energy losses. Solar photovoltaic-thermal systems are another development that produces both electrical and thermal energy from sunlight. Based on the previous studies, the proposed Hybrid Solar-Thermal Water Purifier is designed to utilize solar energy along with an additional heating arrangement for effective water purification. The main aim of this project is to improve thermal efficiency, reduce energy consumption and provide clean water using an economical and eco-friendly method.

III. PROJECT OBJECTIVES

The main objective of this project is to design and develop a Hybrid Solar-Thermal Water Purifier using renewable solar energy. The system aims to purify contaminated water through the process of heating, evaporation and condensation. An additional heating arrangement is used to improve the purification process when solar energy is insufficient. The project focuses on providing clean water with low energy consumption in an economical and eco-friendly manner.

The specific objectives are:

- To design and develop a hybrid solar-thermal water purification system.
- To utilize solar energy for heating and purifying contaminated water.
- To combine solar thermal energy with an additional heating arrangement to improve the purification process.
- To remove impurities and unwanted contaminants from water through evaporation and condensation.
- To improve the thermal efficiency and water production capacity of the system.
- To reduce conventional electricity consumption by utilizing renewable solar energy.
- To develop a low-cost, eco-friendly and energy-efficient water purification system.
- To provide clean and safe water for domestic and small-scale applications.

IV. SCOPE OF THE PROJECT

The scope of this project is to design and develop a Hybrid Solar-Thermal Water Purifier that uses solar energy along with an additional heating arrangement for effective water purification. The system is developed to utilize renewable energy and reduce the use of conventional electrical power. It works on the principle of evaporation and condensation, in which contaminated water is heated to produce water vapour, and the vapour is cooled to obtain purified water. The project focuses on improving the overall thermal efficiency and water production capacity of the purification system. It also aims to reduce heat losses and make better use of the available solar energy. The additional heating arrangement helps maintain the required temperature when solar radiation is insufficient.

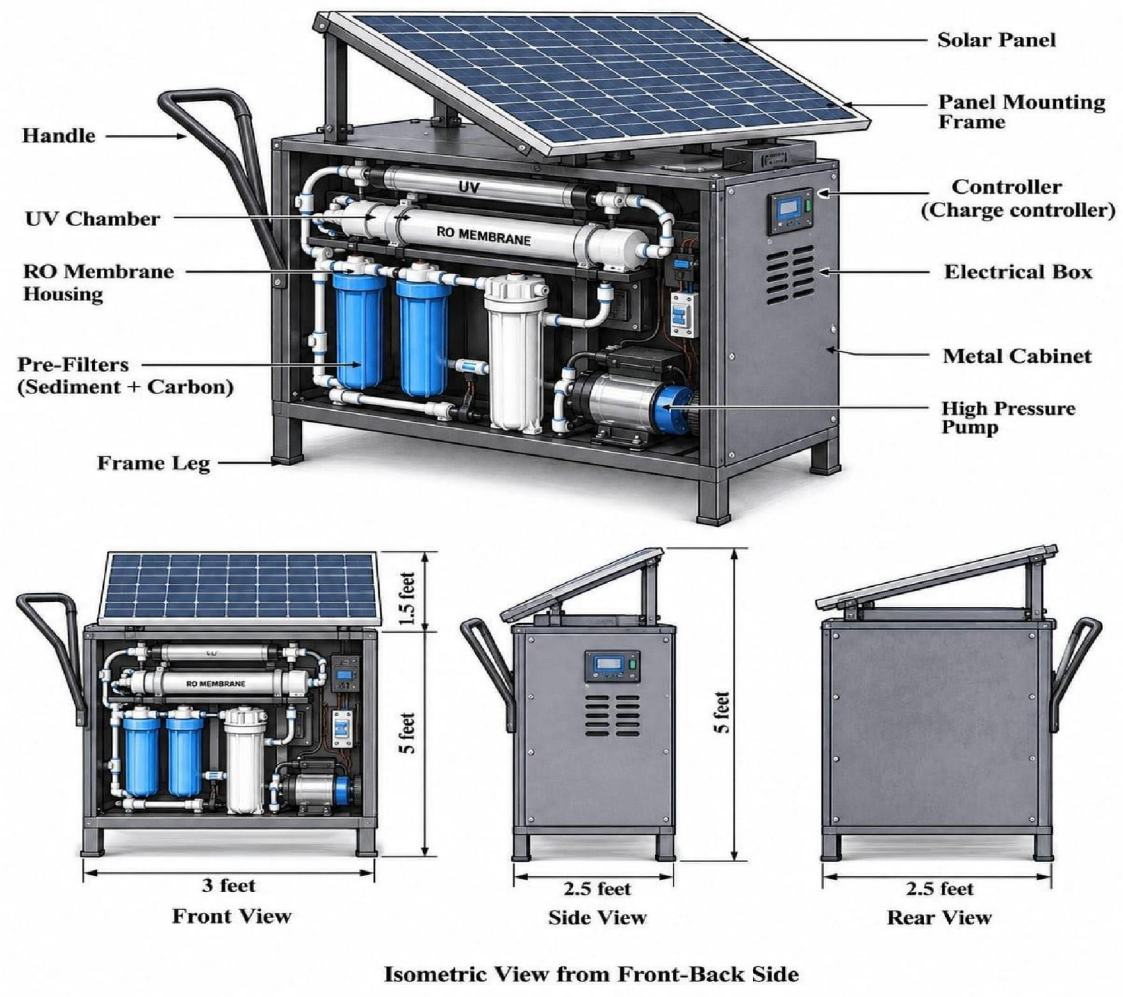
This system can be useful in rural areas, villages, houses and remote locations where access to clean drinking water is limited. It provides an alternative method of water purification with less dependence on conventional energy sources. The system is designed to be simple, economical, easy to operate and require less maintenance. The proposed project

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 3, November 2026
Impact Factor: 8.2

also provides opportunities for future improvements, such as adding thermal energy storage, automatic temperature control, improved insulation and advanced solar collectors.

V. METHODOLOGY AND DESIGN

The project involves designing and fabricating a Hybrid Solar-Thermal Water Purifier using solar energy and an auxiliary heating system. Suitable materials are selected for constructing the frame, water heating chamber, solar collector, and condensation unit. The system uses solar thermal energy as the primary heat source to heat contaminated water. An auxiliary heating arrangement is provided to maintain the required temperature when solar energy is insufficient. The heated water undergoes evaporation, and the generated water vapour is condensed to obtain purified water. The purified water is collected in a storage tank. The performance of the purifier is evaluated by measuring water temperature, purification time, water output, and thermal efficiency.



IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 3, November 2026 Impact Factor: 8.2

VI. RESULTS AND DISCUSSIONS

Hybrid Solar-Thermal Water Purifier

1. Given Dimensions

Assume the following dimensions for the water purifier:

• Length (L) = 4 ft

• Width (W) = 2 ft

• Height (H) = 3 ft Solar collector length = 4 ft Solar collector width = 2 ft

Water storage tank capacity = 20 litres

2. Conversion into Metres

1 ft = 0.3048 m

• Length = 4 × 0.3048 = 1.2192 m

• Width = 2 × 0.3048 = 0.6096 m

• Height = 3 × 0.3048 = 0.9144 m

3. Area of the Solar Collector

Formula:

Area = Length × Width

= 4 × 2

Area = 8 ft²

= 8 × 0.0929

Area = 0.7432 m²

4. Volume of the Water Storage Tank

Assume a rectangular water storage tank.

Formula:

Volume = Length × Width × Height

= 0.4 × 0.25 × 0.20

Volume = 0.020 m³ Volume = 20 litres (1 m³ = 1000 litres)

5. Solar Energy Calculation

Assume average solar radiation = 5 kWh/m²/day.

Formula:

Solar energy received = Collector area × Solar radiation

= 0.7432 × 5

= 3.716 kWh/day

Assume collector efficiency = 40%.

Useful solar energy = 3.716 × 0.40 Useful solar energy = 1.486 kWh/day

6. Water Purification Capacity

Assume the system produces 2 litres of purified water per day.

Density of water = 1 kg/litre.

Mass of purified water = 2 × 1 Mass = 2 kg/day

Assuming 8 hours of operation:

Production rate = 2 ÷ 8

Production rate = 0.25 litres/hour

7. Heat Energy Calculation

Assume 2 kg of water is evaporated.

Latent heat of vaporization of water = 2257 kJ/kg.

Formula:

Energy required = Mass of water × Latent heat

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 3, November 2026 Impact Factor: 8.2

= 2 × 2257
= 4514 kJ
Energy in kWh = 4514 ÷ 3600 Energy required = 1.254 kWh

8. Auxiliary Heater Power Calculation

Assume an auxiliary electric heater is used to provide additional heating.
Heater power = 500 W= 0.5 kW
Assume heater operating time = 1 hour.
Energy supplied by heater = Power × Time
= 0.5 × 1
Energy supplied = 0.5 kWh

9. Final design summary

Parameter	Value
Length	4 ft
Width	2 ft
Height	3 ft
Floor area	8 ft²
Cabinet volume	24 ft³
Solar collector length	4 ft
Solar collector width	2 ft
Solar collector area	8 ft²
Water storage tank capacity	20 litres
Average solar radiation (assumed)	5 kWh/m²/day
Collector efficiency (assumed)	40%
Useful solar energy	1.486 kWh/day
Estimated purification capacity	2 litres/day

VII. CONCLUSION

The project "Design and Fabrication of Hybrid Solar-Thermal Water Purifier" aims to develop an efficient, economical, and eco-friendly water purification system using solar energy and thermal energy. The proposed system utilizes solar radiation to generate heat, which helps in the purification of water by removing impurities and reducing harmful contaminants. The hybrid arrangement improves the reliability of the purification process by utilizing solar energy along with an additional thermal heating source whenever required.

The solar thermal system helps to reduce the consumption of conventional electrical energy and makes effective use of renewable energy. The application of thermal energy in the purification process helps to improve water quality and provides a sustainable approach to obtaining purified water. The hybrid arrangement can also support continuous operation under varying solar radiation conditions, depending on the heating arrangement and system design.

The proposed design is suitable for domestic applications and small-scale rural communities because it can be fabricated using readily available materials. Its performance can be evaluated based on water purification efficiency, temperature achieved, quantity of purified water collected, energy consumption, and operating cost

REFERENCES

1. Tony, M. A., and Nabwey, H. A. (2024). "Recent Advances in Solar Still Technology for Solar Water Desalination." Applied Water Science, 14, Article 147. Springer Nature.
2. Shelake, A., Kumbhar, D., and Sutar, K. (2023). "Desalination Using Solar Stills: A Review." Environmental Progress & Sustainable Energy, 42(3), e14025. Wiley.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 3, November 2026
Impact Factor: 8.2

3. Pathak, A. K., Chopra, K., Tyagi, V. V., Anand, S., Kothari, R., Sari, A., and Pandey, A. K. (2023). "Solar Heat Pipe ETC Integrated with Solar Still System for Water Treatment and Hot Water Production: Novel Hybrid Experimental Approach." Journal of Thermal Analysis and Calorimetry, 148(17), 8969.
4. Chandrashekara, M., and Yadav, A. (2017). "Water Desalination System Using Solar Heat: A Review." Renewable and Sustainable Energy Reviews, 67, 1308–1330.
5. Zhang, Y., Sivakumar, M., Yang, S., Enever, K., and Ramezanianpour, M. (2018). "Application of Solar Energy in Water Treatment Processes: A Review." Desalination, 428, 116–145.
6. Blanco, J., Malato, S., Fernández-Ibáñez, P., Alarcón, D., Gernjak, W., and Maldonado, M. I. (2009). "Review of Feasible Solar Energy Applications to Water Processes." Renewable and Sustainable Energy Reviews, 13, 1437–1445.
7. Saxena, A., Cuce, E., Kabeel, A. E., Abdelgaied, M., and Goel, V. (2022). "A Thermodynamic Review on Solar Stills." Solar Energy.