Journal of Engineering Technology and Sciences
Volume 01, Issue 02, October 2024
www.jets.org.in

Solar Water Distillation (SWD) Plant Structure and Evaluation

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To Cite this Article
K. Aradhana Rao and K. P. Ramakrishna Rao, "Solar Water Distillation (SWD) Plant Structure and Evaluation", Journal of Engineering Technology and Sciences, Vol. 01, Issue 02, October 2024, pp:20-23

Abstract: *Although access to pure water can be restricted in many regions of the world, it is essential for human health and a variety of applications. Water purification is difficult in places with less resources since it frequently takes a lot of energy. There is a great way to purify water using solar energy. Systems that run on solar energy can use sunshine to power UV filtration, distillation, and reverse osmosis, among other purification techniques. These techniques can be economical and effective, particularly in areas with plenty of sunlight. We can minimise environmental effects, cut expenses, and lessen our dependency on conventional fossil fuels by utilising solar energy. Solar water purification systems can also be installed in isolated locations to give local communities long-term access to clean water. Purchasing solar technology not only contributes to addressing the immediate need for clean water while simultaneously encouraging the usage of renewable energy sources, which helps to create a more sustainable future. It's a promising strategy that can greatly increase water quality and accessibility everywhere.A glass plate that absorbs heat and a cotton plate make for an effective solar energy system. Here are some suggestions to raise the effectiveness of the wick and the system as a whole.*

Keywords*: Filters, Solar Energy, and Pure Water*

I. Introduction

the necessity of sustainable practices and the significance that energy plays in human progress. In fact, improving our quality of life requires the effective conversion and utilisation of energy. Here's a closer look at the relationships between solar energy potential, energy, and water purification.
All human endeavours and technological achievements are powered by energy. Energy drives human advancement in everything from industrial operations to daily luxuries. Sustainable development, however, depends on increasing energy efficiency and lowering losses during conversion processes. Although water makes up over 71% of the Earth's surface, much of it is not easily utilised because of contamination or accessibility issues. Despite this, water is needed for life. To maintain agricultural, industrial, and drinking water safety, effective water treatment is essential.

The upper portion's copper plate, glass, and composite wrap material all point to a concentration on heat management and durability. The water flow's tiny tunnel is a great design feature since it enables for accurate moisture control. The wicks in the cubic box at the bottom most likely aid in the dispersion of water, keeping the unit's humidity levels at the proper levels. Maintaining a constant climate is dependent on connecting the lower and upper sections while maintaining an airtight environment. This could have advantages for a number of uses.

It makes logical to emphasise the wick as a vital component, given that maintaining the proper humidity levels depends on its capacity to absorb water through capillary action. In fact, surface tension and capillarity are important factors to consider when choosing wick materials since they affect how well the wick draws water. Selecting the appropriate composition is essential since different materials have different porosities and fibre architectures, which can have a big impact on moisture distribution and absorption rates. Depending on the exact needs of your experiment, you can maximise performance by selecting a particular blend of wicks.

The Solar Water Plant idea is intriguing and presents a novel method of purifying water. By harnessing solar energy for heating and employing a glass wick to facilitate evaporation and condensation, you're constructing a self-sustaining system that reduces environmental effect. Surface tension and capillarity are two processes that are necessary for your system to work. In addition to pulling water upward, the wick keeps the liquid's surface stable, which promotes efficient evaporation and transportation. This is especially crucial in cold climates where condensation can be maximised to gather clean water. You correctly point out that the polarity of water molecules plays a key role in generating surface tension and promoting capillary action. This property is essential for activities like the retention of soil moisture and the movement of water in a variety of settings, including dry ones. It's true that choosing the proper wick material for your solar water plant is essential to maximising water absorption and efficiency. Natural fibres with distinct qualities that can affect how well they work include black glass fibre, polyester, nylon, and fibrous polyurethane.

II. Experimental Work

Through the use of solar energy, the device turns liquid water into vapour and removes contaminants such as salts and microorganisms. You described a creative method for sustainable water purification: water evaporates owing to solar heat and then condenses back, simulating natural processes like rainfall. By doing this, pollutants are decreased and renewable energy is used. It would be very helpful to have a visual aid to better understand the system, such as a figure (Figure 1) that shows the solar water farm concept.

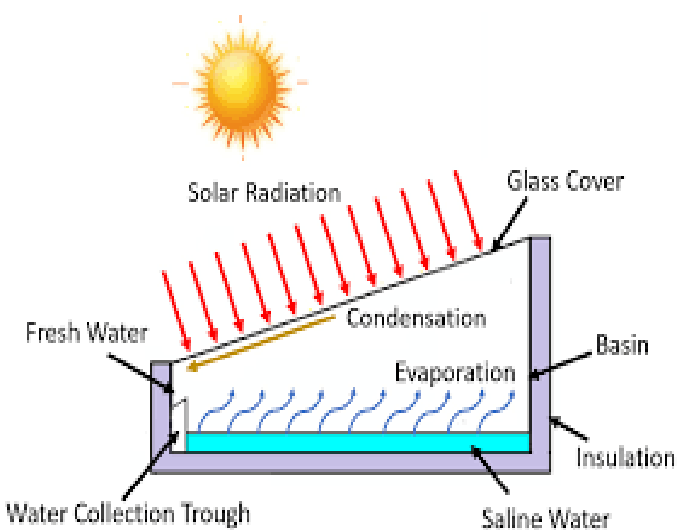

Figure no 1: Model diagram of a solar distillation plant

The glass structure's greenhouse effect is vital because it traps heat, boosts the interior temperature, and facilitates effective evaporation. This reduces heat loss while increasing the greenhouse effect by letting sunlight in. Copper Plate: Because copper plate is a superior heat conductor, heat is transferred to the wicks fast, guaranteeing that they attain the required temperature for efficient evaporation. Drawing water up from the reservoir so that it can be heated and evaporated is made possible by the wicks, which are placed underneath the copper plate. It takes capillary activity to keep the cycle going continuously. The process of condensation occurs when water vapour rises and cools against glass, collecting and so eliminating contaminants and bacteria found in the water. Dark Base: Using a darker substance improves heat absorption, which raises the system's total effectiveness. Rainwater Comparison: Your observation that rainwater is less pure highlights how this technique works to achieve better purification levels by utilising the qualities of both the material and solar radiation. Possible Enhancements: Insulation: To cut down on heat loss and boost efficiency, think about adding insulation to the device's sides. Flow Control: By installing a mechanism to regulate the water's flow to the wicks, the absorption process could be optimised and reliable performance could be guaranteed. Monitoring System: By including sensors to track temperature, humidity, and water quality, the system may be adjusted and real-time data can be obtained.

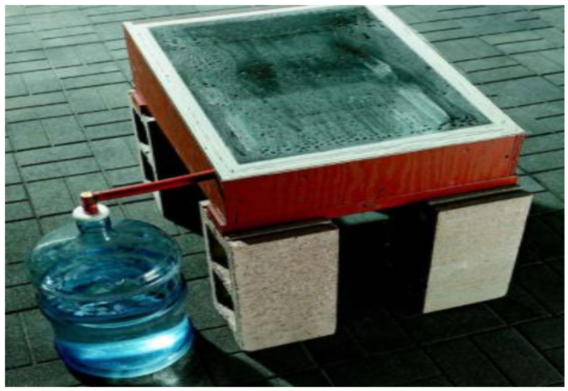

Figure no 2: Solar distillation plant

III. Results and Discussion

The energy available for distillation is directly impacted by the amount of sunlight. Better thermal performance is correlated with higher solar irradiation, which is commonly measured in kilowatts per square meter (kW/m²). Solar days are defined as the amount of time that is effectively exposed to sunlight, typically eight hours, and are crucial in determining potential output. The surface area exposed to sunlight is influenced by the collector's water level. Because of the greater volume, a higher water level can result in lower temperatures and possibly reduced evaporation rates. It is important to have the right level of water; too shallow will not absorb enough heat, and too deep would prevent efficient heating. Elevated water temperatures accelerate evaporation, enhancing the effectiveness of distillation process. That being said, heat loss to the environment needs to be taken into account. Keeping the water at a constant temperature plays a crucial role in optimising thermal efficiency. Enhancing these elements is crucial to raising the efficiency of solar water distillation units. Thermal efficiency can be increased and the amount of clean water produced can be maximised by keeping an eye on and modifying variables like water levels, temperatures, and collector designs. These systems can be further enhanced by technological and material advancements, such as the use of greater insulation or more efficient glass, to make them a practical option for sustainable water purification.

Table no 1: Mass flow rate in lt/m2

Time (hour)	Collected Water (Lts)	Area (m2)	Mass flow rate (Lts/m2/4 hour)
6	0.214	0.21	2.21
6	0.123	0.21	2.22
6	0.213	0.21	2.40
6	0.243	0.21	2.30
6	0.132	0.21	2.70

Table no 2: Efficiency (%)

Solar intensity (W/m2)	Solar power(W)	Efficiency (%)
1020	89.23	19.80
980	92.21	28.23

1321	76.34	36.34
2100	84.23	36.21
782	98.56	38.12

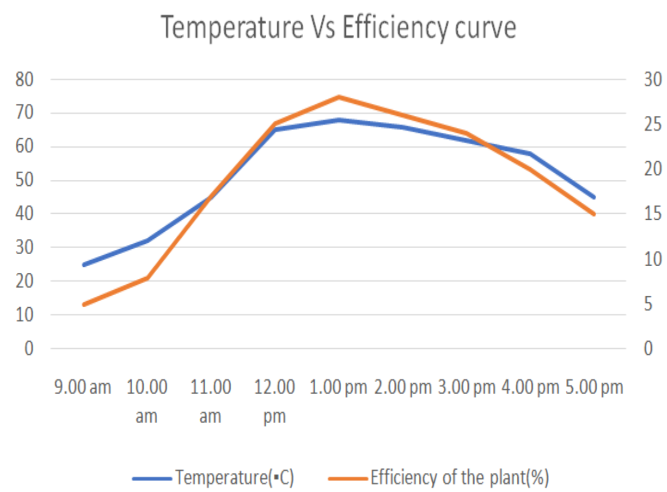

Figure no 3: Temperature Vs Efficiency Curve

IV. Conclusion

The experiment demonstrates the practicality of solar distillation as an environmentally friendly way to purify water. This method, which uses solar energy, offers a workable way to get clean water, especially in places where there is a water shortage. Further system optimisation could boost production and efficiency even more, for example, by strengthening the collector design or the insulation. All things considered, this strategy offers hope for sustainable water management.

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