IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, August 2022

Analysis of Methods of Solar Energy Based Water Purification System for Indian Villages

Navneet Kumar, Associate Professor
Department of Chemistry, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India
Email id- navkchem@gmail.com

ABSTRACT: Solar distillation has proven to be a cost-effective and environmentally friendly method, especially in rural areas. To tackle the problem of decreased distillate output in passive solar stills, many active distillation techniques have been created. The solar still is a handy device for distilling brackish water for drinking. A review of different sorts of sun stills has been done in this article. This page gives a comprehensive overview of several studies on solar energy distillation systems conducted throughout the years. This analysis will also shed light on the need for additional research and recommendations in the field of active solar distillation. In the underdeveloped world, unclean water and sanitation are responsible for 80% of all infections. Solar water disinfection systems that use photo catalysts and UV radiation have shown to be one of the most effective technologies for water purification, particularly in remote areas of underdeveloped countries.

KEYWORDS: solar energy, solar still Distillation system, drinking water.

1. INTRODUCTION

Solar water purification entails using solar energy to purify water for drinking and domestic uses in a variety of ways. Solar energy for water treatment is becoming increasingly popular since it is a low-tech solution that captures the sun's heat and energy to make water cleaner and healthier for human use and consumption. Solar water treatment is especially advantageous for rural populations, who lack conventional types of water purification infrastructure and, more crucially, the energy needed to power such facilities. The most appealing aspect of solar water filtration is that it does not need any fuel. Solar applications are preferable to traditional sources of energy owing to the absence of fuel, since they do not produce pollution (global warming, acid rain, ozone depletion) or health risks connected with pollution. Sun water disinfection (SODIS), solar distillation, solar water pasteurization, and solar water treatment systems are the four major kinds of solar water treatment. Some of these technologies have been known for a long time, but the majority are novel solar energy adaptations. These technologies are basic and easy to comprehend, involve little financial investment, and have been shown to be successful.

The most difficult problems mankind confronts in the twenty-first century are meeting the need for clean water and clean energy. Electricity distribution networks are either inefficient or non-existent in certain developing nations with huge regions and populations. In India, one-third of the population, or 450 million people, does not have access to electricity. In addition, about 1.9 million children die in India each year, with 20% of fatalities owing to gastro-intestinal illness, which is typically caused by contaminated drinking water. More than one billion people across the world do not have access to safe drinking water. In the underdeveloped world, unclean water and sanitation are responsible for 80% of all illnesses. Solar water disinfection systems that use photo-

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, August 2022

catalysts and UV light have been shown to be one of the most effective methods for water purification, particularly in rural areas of poor nations where electrical power is either scarce or non-existent.[1], [2]

1.1 Common Solar Water Purification Methods

1.1.1 Disinfection Of Solar Water

Sun water disinfection is a low-tech, low-cost method of cleaning water that makes use of solar energy and radiation. Aftim Acra et al. from the American University of Beirut were the first to develop SODIS as a technology in 1980. The procedure necessitates the use of polluted water for many hours. The sun's UV rays kill the bacteria that cause diarrhea, making the water safe to drink.[3]

1.1.2 Distillation of Solar Water

Sun water distillation produces clean, pure drinking water by condensing pure water vapor and settling out hazardous elements in a solar still. This procedure is utilized when the water is salty and contains dangerous microorganisms, or when heavy metals need to be settled out, or when sea water has to be desalinated.[4]

1.1.3 Pasteurization of Solar Water

To eliminate disease-causing bacteria, solar water pasteurization uses moderate heat or radiation. Cookers that capture solar energy offer this heat. Bacteria, viruses, worms, and protozoa have all been found to be killed with this technique.[5], [6]

1.1.4 Solar Water Purification

For water filtration, this technique incorporates electricity produced by solar energy. Solar panels provide electricity for a battery that powers filtration and purification devices. These buildings are usually transportable and may be very useful in disaster relief operations. They're also available in a variety of sizes, ranging from small-scale to commercial/community supplies.

1.1.5 Solar water disinfection through photocatalytic therapy

Natural sunshine has long been recognized to have a germicidal impact. In recent research, the concepts of water purification utilizing sunlight, as well as the related procedures and applications, have been studied and extensively utilized.

Photons having energy greater than the band-gap of the semiconductor catalyst (for example, TiO_2) generate electron–hole pairs in a photocatalytic process. In the presence of water and oxygen, electrons with a high reductive potential combine with holes with a high oxidative potential to induce catalytic events on the photo-surface, catalyst's resulting in free hydroxyl

  UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, August 2022

radicals OH. These hydroxyl radicals react with organic molecules in the water, breaking them down into harmless chemicals and disinfecting it.

The rate of purification by sun radiation is related to the intensity and temperature of the radiation, and inversely proportional to the depth of water covering the photo-catalytic surfaces, which is another essential characteristic of the photo-catalytic process. TiO2 has been identified as the most active photo-catalyst among the available semiconductor materials; it is safe, low-cost, and extremely resistant to chemical degradation and photo-corrosion. It can also make use of natural UV from sunshine, which makes it extremely appealing in terms of solar applications.

One of the benefits of these systems is that they don't need tracking since they utilize global sun radiation, which includes both direct and diffuse light. Concentrating systems, on the other hand, operate exclusively with direct-beam radiation, thus the amount of solar energy gathered varies greatly depending on the location; nevertheless, these systems may save money.

2. LITERATURE RIEVEW

M. Gowtham et al. The performance of the solar concentrated distiller with latent heat storage capacity and a solar concentrated distiller with trays on the basin are examined in this study. The latent heat storing medium is paraffin wax. Experiments are carried out to improve productivity, which is achieved via a variety of variables such as heat storage capacity, exposure area, and keeping a low depth. The concentrated solar distiller's hourly productivity was assessed every hour from 9 a.m. to 5 a.m. by keeping a low depth of water. A comparison was conducted between two basin types. By using the capillary effect, sponges were used to expand the exposure area. When compared to the plain basin type, the water production rose by 40.83 percent in the latent heat storage distiller and 19 percent in the tray basin type owing to the inclusion of sponges. Using different changes, overall productivity was increased by up to 48 percent.[7]

Ozuomba J.O. et al. A ceiling solar water filtration (RSWD) kit was built and tested in this article in the real climatic circumstances of Urualla, a historic town in Nigeria's eastern region. A wooden frame basin, an absorber layer, a glass canopy, and a condensate canal are the four main components of the system. Within six days, the RSWD was able to produce 2.3m3 of distilled water. Though the condensation was insufficient in comparison to human need, as is the case with many solar stills, efficiency may be improved by employing a large solar absorbent surface and any other technique that increases radiant energy.[8]

Caroline S.E. Sardella In this article, we examine the production rate of distillate water, which is predicted to be between 100 and 590 l/d per berkad, depending on the system's efficiency. The water collected from the drinking water tank is anticipated to be within the acceptable bacteriological and mineralogical limits, with no detrimental health consequences. During the mixing procedure with the collected rain water, the distillate is anticipated to be partly re-mineralized. During the pilot project, however, precise water quality monitoring and analysis is recommended. The water collected from the drinking water tank is anticipated to be within the

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, August 2022

bacteriological and mineralogical recommended amounts in this project, with no detrimental health consequences. During the mixing procedure with the collected rain water, the distillate is anticipated to be partly re-mineralized. However, throughout the pilot project, precise monitoring and analysis of water quality is recommended. With low-cost technology and low-cost maintenance, it is feasible to enhance the amount and quality of accessible water [9], [10]

Prof. Alpesh Mehta et al. The rise in temperature, and therefore evaporation, is greatest between 11:15 a.m. and 1:30 p.m., according to this study. The highest temperature reached was 53 0C at 1:30 p.m., after which the temperature began to drop. The goal of this experiment was to extract clean water from the brackish water on hand. We provided 14 litres of brackish water and received 1.5 litres at the conclusion of the trial. The trial took place throughout the winter season. The filtered water received has a TDS level of 81 PPM. As a result, the water collected is drinkable. The experiment should yield 2.33 liters in theory. As a result, the system's efficiency is 6%.

Aayush Kaushal et al. There are many ways for desalinating brackish water and converting it to drinkable water, according to this. As a result, several kinds of solar stills for the production of clean water are described. The still efficiency was increased by 20% thanks to a clever combination of cooling film settings. When the diffusion gaps between partitions are increased from 5 mm to 10 mm in a multi-effect diffusion model, productivity drops by approximately 15%. As a result, there is a need to choose solar still very continuously depending on the local environment and operation circumstances for particular requirements.

K. Sampathkumar et al. in this essay, we discussed how unexpected processes and pollution induced by human activities create serious water shortages in developing and developing countries. Water treatment that does not damage the environment is in high demand. In this field, several traditional and non-traditional techniques for purifying saline water have been created. Solar distillation has shown to be a cost-effective and ecologically friendly technique, particularly in rural areas. Several active distillation techniques have been developed to solve the problem of decreased distillate output in passive solar stills. The development of active solar distillation systems is examined in this article.

John ward A black plastic sheet is covered by a white glass pane in this paper design. The plastic is shaped into a grid of linked square cells that hold polluted water. There's no filter, no electronics, and no moving components, so cleaning isn't necessary very often. This solar water purifier has been successfully developed, manufactured, and tested. It can easily convert dirty water (bore, sea, brackish), urine, radioactive, arsenic-contaminated effluent, and so on, into clean drinking water with a TDS level of 1-2ppm. At Adelaide, South Australia, Latitude 35 South, insolation levels of about 1000 W/m result in a daily production of approximately 9 l/m. It's tough, light, and portable, making it ideal for use in isolated areas or third-world nations.

3. DISCUSSION

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, August 2022

The National Solar Mission is a significant effort of the Indian government and state governments to encourage environmentally friendly development while also solving India's energy security issue. The National Solar Mission's goal is to make India a worldwide leader in solar energy by establishing regulatory circumstances that encourage its adoption throughout the nation. The immediate goal is to concentrate on creating a centralized and decentralized framework for solar technology adoption in the nation. Solar power would be most useful in decentralized and off-grid applications, according to this objective, since grid penetration is not possible nor cost-effective, while solar energy applications are. The main issue is determining the best financial approach for covering the high-end initial expenses of these applications with suitable government assistance. Currently, market-based and even micro-credit-based programs have just a small share of this market. The Mission would explore a capital subsidy of up to 30% to encourage new solar energy uses and would set up a non-distorting framework to encourage entrepreneurship, up-scaling, and innovation. The Mission also suggested providing a soft re-finance facility via the Indian Renewable Energy Development Agency (IREDA), for which the Government would give financial assistance, in order to maintain interest within the banking community. IREDA will then supply refinancing NBFCs and banks with funds on the condition that they be on-lend to consumers at interest rates of no more than 5%. The Mission aims to provide a legislative and regulatory framework that offers a predictable incentive structure for fast and large-scale capital investment in solar energy applications, as well as promoting technological innovation and cost reduction. Another undiscovered solar power use that may be investigated under this Mission is solar water filtration. Solar water purification now lacks market mechanisms to encourage its development and spread, but if its application uses are taken into account, it may be a significant endeavor for solar applications, alongside solar photovoltaic products.

In poor nations, waterborne infections cause several billion instances of illness and up to ten million deaths each year, with at least half of the victims being children. Boiling is the most common method for purifying water for food preparation and drinking in poor nations' rural regions. Boiling, on the other hand, is rather costly, requires a significant amount of fossil energy, and the accompanying wood collection contributes to forest loss. Solar water pasteurization is one of the most promising methods for an energy-efficient, cost-effective, durable, and dependable solution to these issues among the current options. Batch and continuous flow solar water pasteurization systems are the two most common kinds. A basic refilling vessel is typically used in batch systems. A batch system typically requires a full day of sunlight to purify water. Water runs through a solar collector in a continuous flow system, which warms the water to the appropriate temperature. To regulate temperature and flow, a thermostat valve is frequently employed. Untreated water is often warmed using heat exchangers.

Regenerator solar water pasteurization devices have been tested by a number of researchers. The performance of a system may be reported in a variety of ways. The output is often expressed in liters per hour per square meter or liters per square meter per day. Unfortunately, daily output cannot be calculated directly from hourly production. Because most systems have a large thermal mass, hourly output rises as the system heats up during the day. Due to a lengthy warm-up period, a system with a high peak hourly output may have a low daily production. The weather patterns are not always mentioned when daily data are given. When daily production is provided, it is believed that it is for a clear day, although the date and hours of daylight are often not mentioned. Some studies report output per MJ or kW h of sunshine as an alternative.

Jorgensen et al. (1998) utilized flat plate solar collectors to pasteurize water. The flow was controlled by an adjustable thermostat valve. The impact of the valve set point on microorganism inactivation was investigated. The collector handled approximately 50 l/m2-day at a fixed point of 75 degrees Celsius. Stevens et al. developed and tested a flat plate solar water pasteurizer with an integrated heat exchanger (1998). The device used an automobile thermostat to regulate flow and heated the water to approximately 75 degrees Celsius. The system was capable of treating up to 55 l/h-m2 after a considerable warm-up time.

A flat plate solar pasteurization system is made by Safe Water Systems. The technology pasteurizes water at 79 degrees Celsius using a custom-designed valve. The system may generate up to 95 l/h during steady state operation and up to 760l/day [205 l/m2-day] with a heat exchanger and a collector area of 3.7 m2.

4. CONCLUSION

Solar panels are still environmentally beneficial. The many kinds and advancements in active solar capabilities to produce designated levels, as well as analytical approaches and future research opportunities, were all thoroughly examined. The yearly output is at its greatest when the condensing glass cover angle is equal to the latitude of the location, according to the study and discussions. The yield of a multilevel desalination unit with heat recovery is greater than that of a basic solar still. The length of the solar still, the depth of the water in the basin, the temperature of the input water, and solar radiation are the main factors that influence the still's effectiveness. Using energy-storing materials in the active solar stills allows for higher output at night. The most difficult problems mankind confronts in the twenty-first century are meeting the demands for clean water and clean energy. This is a particularly tough issue for underdeveloped nations. In India, for example, one-third of the population, or 450 million people, live without power. In India, however, about 1.9 million children die each year, with 20% of these fatalities due to gastro-intestinal illness, which is mostly caused by the use of contaminated drinking water. Solar water disinfection systems that use photo catalysts and UV light have been shown to be one of the most effective water purifying methods. The suggested method will be especially suited for areas in poor nations where access to electrical power is restricted or nonexistent because it integrates clean, renewable energy production into the water purification system.

REFERENCES:

[1] W. S. Duff and D. A. Hodgson, “A simple high efficiency solar water purification system,” *Sol. Energy*, 2005, doi: 10.1016/j.solener.2004.10.005.

[2] R. R. Avezov and Z. S. Akhatov, “Heat utilization coefficient of solar water purification stills with multistage vaporization-condensation chambers,” *Appl. Sol. Energy (English Transl. Geliotekhnika)*, 2007, doi: 10.3103/S0003701X07020016.

[3] M. Castro-Alférez, M. I. Polo-López, and P. Fernández-Ibáñez, "Intracellular mechanisms of solar water disinfection," *Sci. Rep.*, 2016, doi: 10.1038/srep38145.

[4] "Fabrication of Solar Water Distillation," *Int. J. Innov. Eng. Technol.*, 2017, doi: 10.21172/ijiet.83.005.

[5] N. Safapour and R. H. Metcalf, "Enhancement of solar water pasteurization with reflectors," *Appl. Environ. Microbiol.*, 1999, doi: 10.1128/aem.65.2.859-861.1999.

[6] D. A. Ciochetti and R. H. Metcalf, "Pasteurization of naturally contaminated water with solar energy," *Appl. Environ. Microbiol.*, 1984, doi: 10.1128/aem.47.2.223-228.1984.

[7] J. N. Gordes and J. Perlin, "An historical and prospective review of solar water purification," 2005.

[8] Y. S. Kapnichor, "A Review on Solar Still Water Purification," *Int. J. Innov. Res. Sci. Technol.*, 2017.

[9] O. Omitade, O. O. Ajani, O. Ogedengbe, and R. A. Akanbi, "Low cost solar powered ultra violet purification system for rural communities," 2009.

[10] K. Sampathkumar, T. V. Arjunan, P. Pitchandi, and P. Senthilkumar, "Active solar distillation-A detailed review," *Renewable and Sustainable Energy Reviews*. 2010, doi: 10.1016/j.rser.2010.01.023.