C. Anbumeenakshi, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 12, Issue 4, (Series-II) April 2022, pp. 53-57

RESEARCH ARTICLE OPEN ACCESS

Experimental study on Green (Solar) desalination system using Fresnel lens

C. Anbumeenakshi[1], M.M.Banshidhar Mahish[2], N.S Dhanushraam[3], M. Maruthasankar[4]

[1]*Associate Professor, Dept of Mechanical Eng, K.L.N. College of Engineering, Madurai, Tamil Nadu, India*
2,3,4 Student, Dept of Mechanical Eng, K.L.N. College of Engineering, Madurai, Tamil Nadu, India

Abstract. Solar energy is one of the most powerful sources for many sustainable applications.. The fresh water productivity depends on how efficiently the system harvests the incoming solar energy and converts it into useful heat. In this study, a Fresnel lens has been used to concentrate solar energy onto a spot to increase the local temperature of feedwater and the evaporation rate. The experimental study was conducted using saline water as the sample and desalination was carried out using the designed system. The effectiveness of solar collection is increased by the integration of Fresnel lens and copper rods. It is an Energy- efficient option because we use solar energy for the desalination of saline water. This project works on the basic principle of desalination. Thus in this project Fresnel lens is used to converge and maximize the solar energy falling on the copper plate from which the heat is conducted to the water tank through copper coil and then the steam generated is condensed. The condensed desalinated water will be collected separately.

Keywords: Solar energy, solar desalination, Fresnel lens, concentrated solar power,

---

Date of Submission: 09-04-2022 Date of Acceptance: 26-04-2022

I. INTRODUCTION:

Water is a precious resource that is scarce in many parts of the world and is gradually becoming insufficient in the rest of the planet due to population growth and water contamination. Water purification by desalination is a low-tech and low- cost process that can be easily implemented anywhere on the world. The only major drawback is that it consumes a lot of energy. However, the sun is an abundant and inexhaustible energy source that is available almost anywhere on the planet that could be used for water purification by desalination. About 71% of the planet is covered with water. yet all of that 96.5% of the planet_s water is found in oceans, 1.7% in groundwater, 1.7% h glaciers and the ice caps and 0.001% in the air as vapor and clouds, Only 2.5% at the Earth's water is freshwater.As over 97% of water on earth available is saline, it can be desalinated (Desalination) to produce fresh water and thus increasing the availability of fresh water. Also this desalination could be powered by the energy received from the sun as solar energy is readily available during the day, solar energy is a renewable and long term available resource that eliminates the dependency on fossil fuels to produce desalinated water. Also producing energy from sun is completely clean (Green) as it doesn‘t produce any carbon emissions. The world meteorological organization uses the term ―sunshine duration‖ to mean the cumulative time during which an area receives direct irradiance from the sun of at least 120 Watts per square meter. Other sources indicate an ―Average over the entire earth of 164 Watts per square meter over a 24 hour day.

Christopher et al [1] designed a small thermal desalination unit for use in refugee camps or in emergency situations that might be found after natural disasters. The thermal evaporation and condenser stages are separated for higher efficiency and the process is powered by low-cost PMMA concentrating Fresnel lenses The durability of the PMMA Fresnel lenses has been assessed, with good results.

Nagasundaram, and Karuppasamy [2] made a detailed theoretical and experimental study in the solar still and minimizing the energy loss by implementing the Fresnel lens and increasing efficiency, net distillate output of solar still.

Choong et al [3] performed an experimental study and the experiments were conducted for two different geometries and

alongside the comparison between the conventional and the modified solar still; the number of Fresnel lenses was also varied. It was found that using two Fresnel lenses instead of a single large one gives a boost to the production of freshwater per unit solar irradiation by 39%.

Het et al [4] designed and constructed a solar powered desalination system using Fresnel lens.It was identified that the amount of condensate collected is directly proportional to amount of water in solar still.

Haneef et al [5] carried a detailed experimental study in purification of sea water. The solar energy and convex lenses were used for the purification of seawater.

Chandrakumar et al [6] performed a detailed experimental study and it was identified that the effectiveness of solar collection is increased by the integration of Fresnel lens and parabolic reflector.

The aim of this experimental study is to design and construct a solar powered desalination system using Fresnel lens and copper rods for the conversion of saline water into pure water. The Fresnel lens is used to converge and maximize the solar energy falling on the copper plate from which the heat is conducted to the water tank through copper coil and then the steam generated is condensed. The condensed desalinated water will be collected separately.

From the literature studies it was identified that the direct contact of sunlight from the fresnel lens is not possible as there is condenser unit in between the fresnel lens and the water which is more important in the process of desalination. So, the radiation method of desalination is not possible. Hence in this a conduction method of heat transfer from the fresnel lens to the water was preferred. This method doesn‘t affect the placement of condenser plate in between the model.

Experimental Setup

The Green Desalination project consists of the glass water tank as a water reservoir in which saline water is filled up to certain height below the partition glass.The partition glass is fitted at one third distances from the end of the reservoir which acts as the divider between saline and desaline water. The edges of the reservoir are protected with beading rubber which also acts as the seat for the top cover. The top cover which is made up of acrylic sheet is attached with the condenser plate with a help of mechanical joints and seated on the beading rubber. The top cover has several holes to assist in the connection of hoses and copper coil. The copper coil which is welded with copper plate is inserted in the reservoir through the top cover and the condenser plate. The condenser plate is tilted about 12^{o} to regulate the flow of the condensed droplets towards the desaline side. The condenser plate has an inlet and outlet holes through which coolant water flows inside and outside. The cooling process is enhanced by attaching five numbers of baffles to the bottom of the condenser plate. The coolant water is pumped using centrifugal pump and after the condensation process is done, it is then cooled using air cooled condenser. The fresnel lenses are placed on the fresnel frame with fasteners. The framesare jointed accordingly so they can be rotated along the x – axis. The frame holder is jointed with frame stand which is made up of steel. The frame holder can also be rotated along z – axis. Fig.1 and 2 show the photographic view of water reservoir with condenser plate and Fresnel lens. Figure 3 shows the photographic view of microchannel test section.

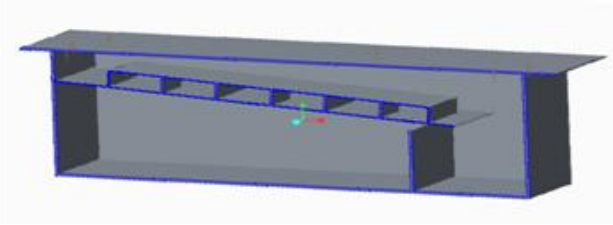

Fig: 1 Sectional view of water reservoir with condenser plate

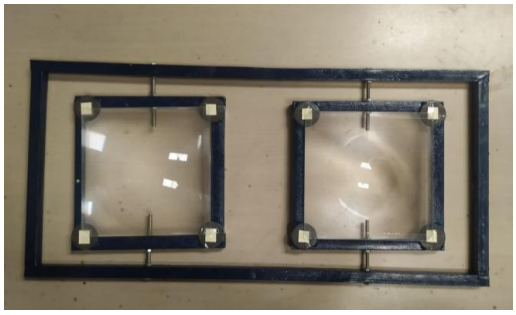

Fig2: Fresnel lens

Fig:3 Solar desalination set up

II. EXPERIMENTAL PROCEDURE

The aim of the study of Green Desalination is to design and construct a solar powered desalination system using Fresnel lens and copper rods for the conversion of saline water into pure water. Here we are using Fresnel lens to converge and maximize the solar energy falling on the copper plate from which the heat is conducted to the water tank through copper coil and then the steam generated is condensed. The condensed desalinated water will be collected separately.

The green desalination system works on the basic principle of evaporation and condensation.The solar irradiation is the amount of solar energy per unit area which falls on the fresnel lens. The fresnel lens converges the radiation on the copper plate. The copper which has greater thermal conductivity conducts the heat energy to the coil. The coil conducts the received heat to the water. The process continues until the water reaches its boiling temperature. Once the saturation temperature reached, the water gets evaporated. Evaporation is the process by which water changes from a liquid to a vapor. Evaporation is the primary pathway that water moves from the liquid state back into the water cycle as atmospheric water vapor. The evaporated vapour moves up and touches the condenser plate and due to the temperature difference, the vapour gets condensed into liquid droplets. Condensation is the change of the physical state of matter from the gas phase into the liquid phase, and is the reverse of vaporization. It can also be defined as the change in the state of water vapor to liquid water when in contact with a liquid or solid surface within the atmosphere. The condensed droplets float on the smooth surface of the acrylic due to the inclination and gets collected on the desaline side of the reservoir. Once the desalination process is over, the desaline water gets collected through the hole on the top cover using hand pump. The fig. 4 shows the schematic diagram of experimental set up.

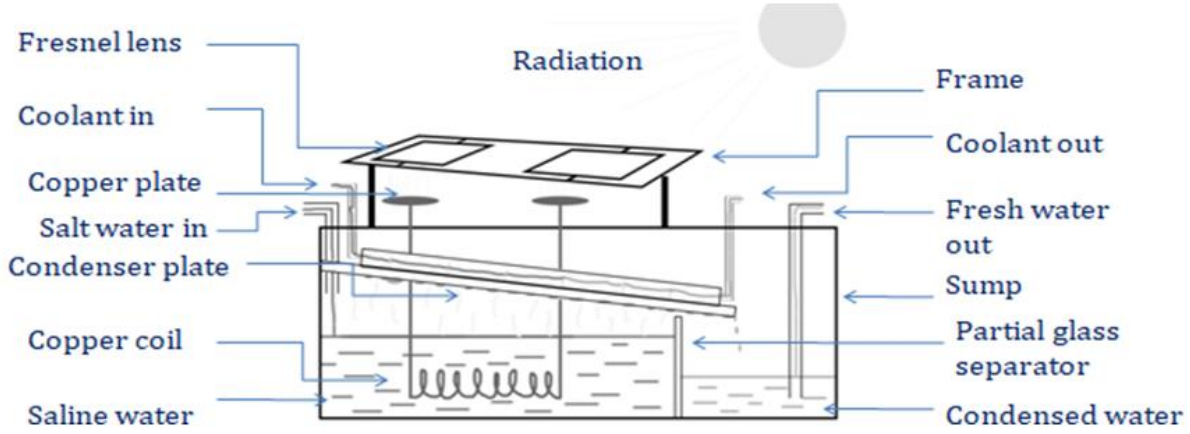

Fig 4: Schematic diagram of the experimental setup

III. RESULTS AND DISCUSSION

The setup was placed in the open region where direct sun radiation available without any restriction. The water reservoir is filled with saline water and the fresnel lens is adjusted according to the sun tracking. Total volume of saline watertested is 10 litres.

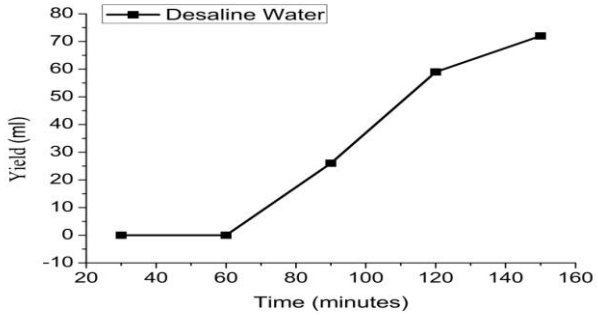

Figure 4 Desaline water yield with respect to time

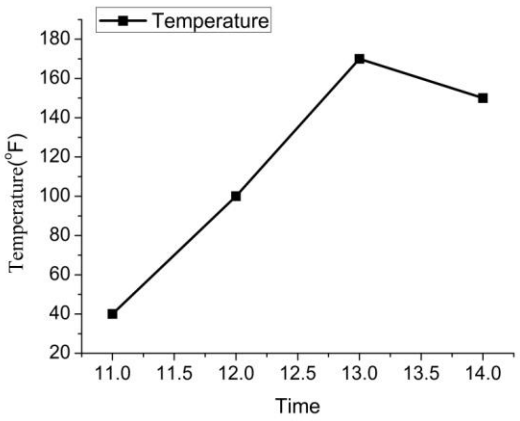

Fig.5 Temperature Vs Time

From the above reading, it is observed that this setup of two fresnel lens took up to 2 hours to desaline 60 ml of water. The amount of yield produced depends upon the following factors:

- Solar Irradiance
- Size of fresnel lens
- Number of fresnel lens

Irradiance on Earth's Surface:

Average annual solar radiation arriving at the top of the Earth's atmosphereis roughly 1361 W/m^2. The Sun's rays are attenuated as they pass through the atmosphere, leaving maximum normal surface irradiance at approximately 1000 W/m^2 at sea level on a clear day. When 1361 W/m^2 is arriving above the atmosphere (when the sun is at the zenith in a cloudless sky), direct sun is about 1050 W/m^2, and global radiation on a horizontal surface at ground level is about 1120 W/m^2. The latter figure includes radiation scattered or reemitted by atmosphere and surroundings. The actual figure varies with the Sun's angle and atmospheric circumstances.

Size of Fresnel lens:

The concept of the fresnel lens is that it focuses the sun radiation falling on its area into a single point, hence producing maximum energy. Therefore, if we increases the size of the fresnel lens, the area increases and hence the energy which results in the higher evaporation rate.

Number of Fresnel ens:

The concept of the fresnel lens is that it focuses the sun radiation falling on its area into a single point, hence producing maximum energy. Therefore, if we increases the number of the fresnel lens, the area adds and hence the energy which results in the higher evaporation rate.

IV. CONCLUSIONS

As the world's population continues to grow, existing water supplies will become increasingly insufficient. As more and more water is required to meet mankind's needs, desalination of saline water will become an increasingly important source of useable water. Solar energy has the best potential to become a feasible solution to the growing energy and water crisis in the planet. There is a huge untapped area for development of technologies based on solar energy. The usage of Fresnel lens greatly increases the rate of evaporation of water and by Using multiple Fresnel lenses instead of a single one provides multiple hotspots and causes more evaporation of feed water, thus leading to higher total production per total solar irradiation.

The design set-up for the solar powered desalination system using Fresnel lens can desalinate saltwater. Fresnel lens made of acrylic plastic can be used as a solar concentrator for a solar powered desalination system. This study has opened up the possibility of further exploration in this field through more vigorous experiments.

ACKNOWLEDGEMENTS

The authors would like to thank the Management of K.L.N. College of Engineering for providing the facilities to carry out the research work.

REFERENCES

[1]. Christopher Sansom, Xavier Tonnellier, Peter King, and Heather Almond, "Concentrating Fresnel lens technology for thermal desalination",AIP Conference Proceedings 2126, 230003 (2019)

[2]. D. Nagasundaram1, K. Karuppasamy, " Desalination Of Sea Water By Using Solar Still With Fresnel Lens", International Journal of Advanced Research in Biology Engineering Science and Technology (IJARBEST) Vol. 2, Issue 6, June 2016

[3]. Wing Sum Choong, Zhi Yong Ho and Rubina Bahar, "Solar Desalination Using Fresnel Lens as Concentrated Solar Power Device: An Experimental Study in Tropical Climate", Frontiers in Energy Research, Volume 8 , October 2020

[4]. Het Patel, Meet Patel, Mihir Patel, Yash Patel, Mohsin J.Dadi," Performance Of Water Heating And Distillation Using

Fresnel Lens Solar Collector", JETIR,Volume 6,2019.

[5]. Mahenaz Haneef, Chandan Kumar, Sakshi Agrahari, Anamika Tripathi ,Shorab Ali Khan, "Purification Of Sea Water Using Lenses And Solar Energy", IJSART - *Volume 4 Issue 4 – APRIL 2018*

[6]. K.S.Chandrakumar, N.Balamani, S.B.Balaji, A.Adhavan4, M.Dineshkumar, "Solar Distillation Using Fresnel Lens And Parabolic Reflector With Integrated Drip Mechanism", IJARIIE, Vol-4 Issue-2 2018

C. Anbumeenakshi, et. al. "Experimental study on Green (Solar) desalination system using Fresnel lens." *International Journal of Engineering Research and Applications (IJERA)*, vol.12 (04), 2022, pp 53-57.