



## Comparative Study of Fresh Water and Sea Water for Cooling System Solar Panel Energy

Rindi Wulandari<sup>1</sup>, M. Riyad Ariwibowo<sup>1</sup>, Taryo<sup>1</sup>, Galieh Ananda<sup>1</sup>, and Mohamad Dimas Nur Hakim<sup>1</sup>

<sup>1</sup>Dept. of Electrical Engineering, Faculty of Engineering, University of Swadaya Gunung Jati, Indonesia.

### KEYWORDS

*Comparative Study  
Fresh Water  
Sea Water  
Cooling  
Solar Panel*

### ARTICLE HISTORY

*Received 29 March 2025  
Received in revised form  
8 April 2025  
Accepted 16 April 2025  
Available online 27 April 2025*

### ABSTRACT

Solar panels are one of the renewable energy sources that have the most significant potential in the world. However, one of the problems of solar panels is the effect of temperature on their performance so that it requires other alternatives to overcome this problem, one of which is the installation of a cooling system. In the active cooling system that is made, namely using water spray, the purpose of this study is to compare the effectiveness of the cooling fluid between fresh water (aquades) and sea water. The method used is experimental and data testing. From the results of the study, it was found that the comparison of current and voltage data between fresh water (aquades) and sea water has a characteristic curve shape that is almost the same with a difference in value that is not too significant. The average current value for fresh water and sea water coolers is 0.66 A and 0.63 A. While the average voltage value for fresh water and sea water coolers is 14.55 V and 14.44 V. The total power generated during 6 hours of operation by solar panels with fresh water cooling is 125.81 Watts, while the total power of solar panels with sea water cooling is 119.45. The efficiency obtained is 5.32%. The average value of the temperature of the freshwater and seawater coolers is 39.2°C and 40°C. Based on the results of the study, fresh water is highly recommended as a cooling fluid for solar panels with the water spray method. In addition, review the effects of seawater, which will also cause corrosion on solar panel materials. However, seawater can be an option when the installation of solar panels is carried out at sea because of the seawater sources available at the installation location.

© 2025 The Authors. Published by Penteract Technology.

This is an open access article under the CC BY-NC 4.0 license (<https://creativecommons.org/licenses/by-nc/4.0/>).

## 1. INTRODUCTION

Renewable energy in the form of solar panels is one of the most potential energies and is the main choice in the world. As a tropical country, Indonesia has great solar energy potential, with an average solar radiation intensity of 4.8 kWh/m<sup>2</sup>/d[1]. Solar panels are widely used to convert sunlight into electrical energy. However, there are several issues related to the use of solar panels. The first problem is the investment price which is still expensive, the second is the efficiency which is still low, and the third is the influence of the environment such as dust and temperature changes.[2], [3], [4].

Solar panels consist of semiconductor materials that are sensitive to temperature changes[5]. At high temperatures, the surface of solar panels that are continuously exposed to sunlight

will decrease efficiency by 0.5% for every 1°C increase in temperature (starting from 25°C) [6], [7]. The efficiency of solar panels is affected by their operating temperature. At higher temperatures, the output efficiency of solar panels can decrease significantly[8], [9]. One method for solving the problem of decreasing efficiency due to increasing temperature is to create a cooling system on the surface of the solar panel.

Therefore, it is important to implement an effective cooling system to maintain the optimum temperature of the solar panels. There are two types of solar panel cooling methods, the first is active cooling, which is cooling that requires external power sources, and passive cooling that comes from natural processes [10].

\*Corresponding author:

E-mail address: Rindi Wulandari <[rindi.wulandari@ugj.ac.id](mailto:rindi.wulandari@ugj.ac.id)>.

<https://doi.org/10.56532/mjsat.v5i1.510>

2785-8901/ © 2025 The Authors. Published by Penteract Technology.

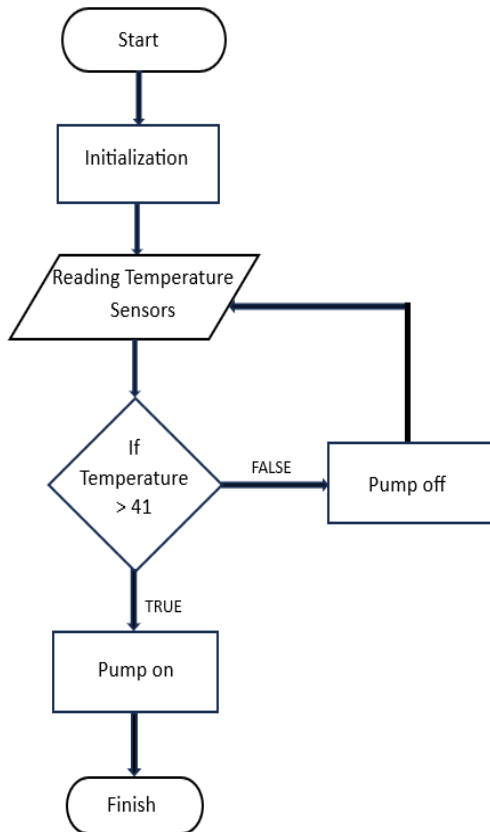
This is an open access article under the CC BY-NC 4.0 license (<https://creativecommons.org/licenses/by-nc/4.0/>).

Among the various active cooling methods, namely the use of water-based cooling media, both sea water and fresh water, these media are two interesting options to study. In addition, the use of fluid media can also be adjusted to the location of the solar panel installation. Several studies have shown that cooling media have a major impact on the performance of solar panels. Cooling systems using mineral water and sea water show significant differences in cooling efficiency, where fresh water shows an efficiency of 14.01% and sea water 13.06% under certain conditions[11]. However, in this study only one solar panel was used so that there is a possibility that the surface of the solar panel was contaminated with a mixture of distilled water and salt water.

Other studies also show the advantages and disadvantages of each cooling medium. Fresh water has the advantage of being available and performing better in maintaining optimal temperatures for the panels[12]. However, fresh water can also be more expensive if the source has to be treated or transported long distances. On the other hand, seawater, although potentially damaging to solar panel materials through corrosion, is usually more accessible in coastal areas. This is the basis for the study conducted, namely comparing the effectiveness of fresh water and sea water as cooling media for solar panels.

**2. METHODOLOGY**

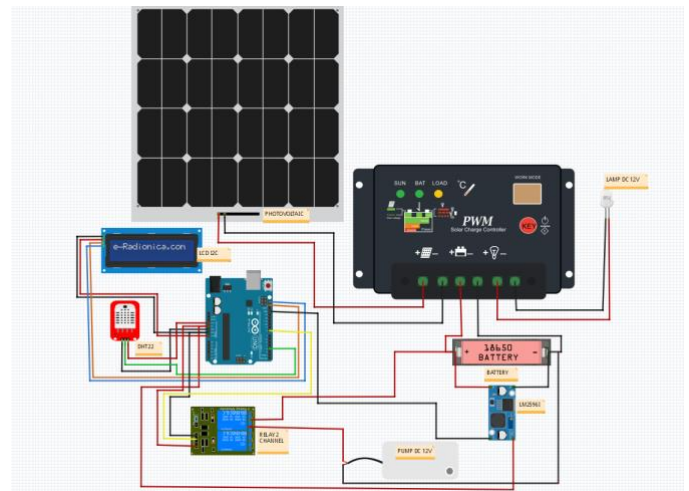
The methodology in this study uses an experimental type [13]. The purpose of this experiment is to test seawater and freshwater coolants on solar panels and find the incoming voltage, current and surface temperature [14]. Figure 1 shows the flow diagram of the cooling system



**Fig. 1.** Flow diagram of the cooling system

Figure 2 shows the wiring diagram of the solar panel cooling system, and table 1 shows the specifications of the solar panels used.

The hardware design for the solar panel cooling system utilizes the Arduino Uno microcontroller as the brain of the controller. The solar panel as an energy producer, to detect the temperature a DHT22 sensor is used which will activate the pump in response. The mechanism of the solar panel cooling system is implemented through a pump that sprays water or a fan that emits wind that will cool the solar panel. As energy storage, a 12 V battery is used to store the power generated by the solar panel, and the LM2596 DC to DC Step Down module is used to lower the voltage before entering the Arduino.



**Fig. 2.** Wiring diagram and the component of the cooling system

The cooling system will be active if the temperature sensor reads the solar panel surface temperature has a value of more than 41°C then the cooling system starts to activate, and if the solar panel surface temperature has a value of less than 41°C the cooling system becomes inactive. The active duration of the cooling system depends on the surface temperature of the solar panels. When testing fresh water and sea water cooling media, it is carried out at the same time. The cooling system consists of 4 water jet nodes with one source coming from a 12 Volt DC pump. Basic calculation. The main calculation relation is the equation of efficiency system[15], [16].

$$power\ efficiency = \frac{(P_{Aquades} - P_{sea\ water})}{P_{sea\ water}} \times 100\% \quad (1)$$

When  $P_{aquades}$  is Power from a solar panel with aquades as a coolant fluid, and  $P_{sea\ water}$  is a solar panel with sea water as a coolant fluid.

**3. EXPERIMENTAL SETUP**

The experiment was carried out from 08.00-10.00 at the University of Swadaya Gunung Jati (7GCW+C9) Sunyaragi, Cirebon City, West Java, Indonesia. Solar panels are in a static position at an angle of 30° and facing west.

**Table 1.** Solar Panel Specifications

Materials	Monocrystalline
Maximum voltage value	18 volt
Maximum current value	1.11A
Maximum power value	20 Watt
Size	450 x 350 x 15 mm

Temperature measurements are carried out with a thermos gun and DHT22 sensor embedded in each system. Figure 3 shows the model of the solar panel system that was created, and conditions under which testing is taking place. The environmental temperature in the Cirebon area is around 29-32°C.

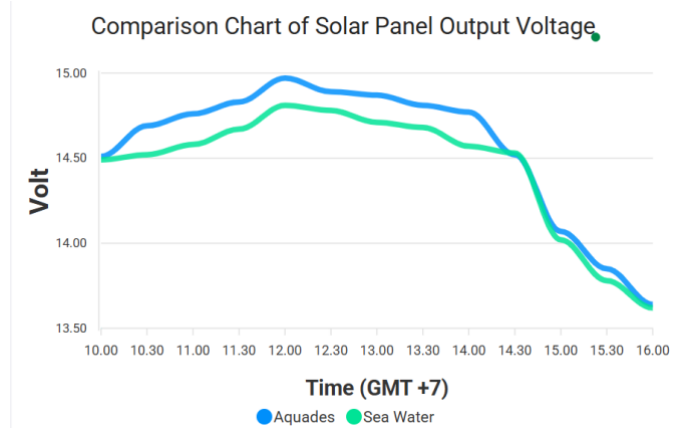


**Fig. 3.** Condition of solar panels during fluid comparison testing

**4. RESULT AND DISCUSSIONS**

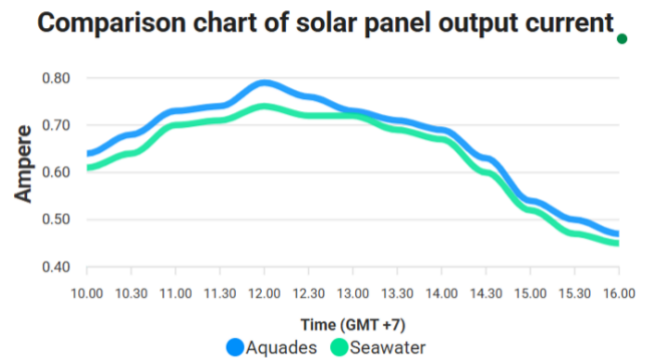
Testing was conducted at the same time for a 20 WP solar panel. The cooling system is designed to be active at a panel surface temperature of 41°C, and will be inactive when the solar panel surface temperature is below 41°C. Testing was conducted by measuring the output voltage and current of the solar panel. In addition, PH measurements were also carried out on each cooling medium. Figure 4 shows the voltage measurement on the solar panel when using two types of coolants.

Figure 4, it can be seen that the characteristics of the graph with seawater and distilled water cooling are not much different, only the voltage value on the seawater-cooled solar panel always has a lower value every time. Based on the data, the average voltage obtained with seawater cooling is 14. 14.44 Volts, while the solar panel cooling system with distilled water is 14.55 Volts.



**Fig. 4.** Graph of solar panel voltage measurement with two cooling media

Figure 5 shows the comparison of the current values generated by solar panels using two different cooling media. The characteristics of the current data are similar to the voltage measurement data, where the results of current measurements with seawater cooling media always have lower values than the current values with distilled water cooling. From these data, the average value for the current with seawater cooling is 0.63 A and the average current value with distilled water cooling is 0.66. The results of this average calculation show that the difference in current values from the two media is not too significant.



**Fig. 5.** Graph of solar panel current measurement with two cooling media

From the current and voltage data, the value of the power generated is obtained. The characteristics of the power generated are shown in Figure 6. From the graph, it can be seen that the power of solar panels with fresh water cooling always has a higher value than the power of solar panels with sea water cooling.

The total power generated during 6 hours of operation by the solar panel with fresh water cooling is 125.81 Watts, while the total power of the solar panel with sea water cooling is 119.45. The difference in the total power obtained is not too significant.

### Comparison Chart of Solar Panel Output Power

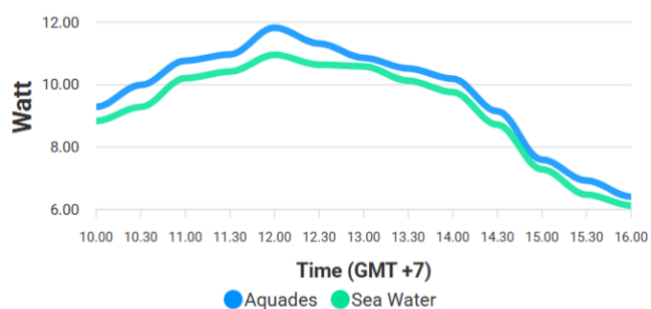


Fig. 6. Graph of power solar panel with two cooling media

The power efficiency obtained is 5.32%, this shows that there is better efficiency if using distilled water as a coolant compared to sea water as a cooling fluid. In previous research, similar research when comparing various cooling fluids on solar panels with one solar panel, the efficiency was 0.38% in the comparison of distilled water and sea water cooling [11]. The use of distilled water as a cooling fluid is more recommended, because this also affects the speed of the fluid in lowering the temperature on the solar panel as can be seen in the solar panel temperature characteristic graph in Figure 7.

From the surface temperature graph of the solar panel, it can be seen that the temperature characteristics fluctuate. There is one condition where the temperature with seawater cooling has a lower temperature value, namely at 12.30 WIB. However, in general, the average surface temperature value of the solar panel with aquades cooling is lower than the solar panel with seawater cooling. The average surface temperature of the solar panel with aquades cooling and seawater cooling is 39.2°C and 40°C.

### Chart of Comparison for Solar Panel Surface Temperature

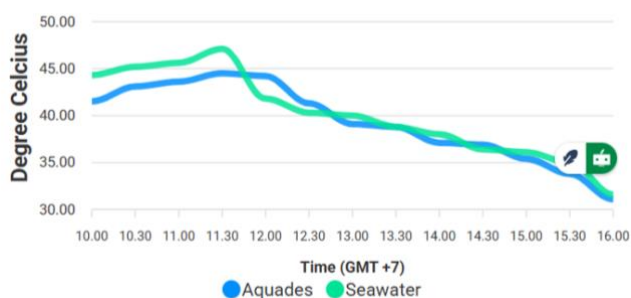


Fig. 7. Graph of solar panel surface temperature

In figure 8, shows the results of water PH measurement by PH meter. At the time of testing, the measurement results obtained with fresh water PH value is 7.1 and sea water PH value is 8.1. from the high sea water PH value, of course it is not recommended to be a cooling system on solar panels that have semiconductor material because it will be corrosive.

From this research, another advantage obtained when using the water spray method as a solar panel cooler besides as a controller of the solar panel surface temperature, is as a dirt remover on the solar panel surface. In several references, many methods are used to remove dirt such as dust, or leaves on solar

panel installations and the most widely used is the water spray method[17].



Fig. 8. Fresh water PH measurement

## 5. CONCLUSION

An active cooling system using water spray has been successfully created and implemented. The cooling media used in this research are fresh water and sea water, each of which is applied to 20WP solar panels. From the results of the study, it was found that the comparison of current and voltage data between fresh water (aquades) and sea water has a characteristic curve shape that is almost the same with a difference in value that is not too significant. The average current value for fresh water and sea water coolers is 0.66 A and 0.63 A. While the average voltage value for fresh water and sea water coolers is 14.55 V and 14.44 V. The total power generated during 6 hours of operation by solar panels with fresh water cooling is 125.81 Watts, while the total power of solar panels with sea water cooling is 119.45. The efficiency obtained is 5.32%. The average value of the temperature of the freshwater and seawater coolers is 39.2°C and 40°C. Based on the results of the study, fresh water is highly recommended as a cooling fluid for solar panels with the water spray method. In addition, review the effects of seawater, which will also cause corrosion on solar panel materials. However, seawater can be an option when the installation of solar panels is carried out at sea because of the seawater sources available at the installation location.

## ACKNOWLEDGEMENT

The authors would like to thank the Research Department of Swadaya Gunung Jati University for providing the opportunity to conduct this research and provide support to researchers.

## REFERENCES

- [1] A. Setiawan and E. Adhi Setiawan, "Optimization of a Photovoltaic Power Plant in Indonesia with Proper Tilt Angle and Photovoltaic Type using a System Advisor Model," *Int. J. Technol.*, vol. 8, no. 3, p. 539, Apr. 2017, doi: <https://doi.org/10.14716/ijtech.v8i3.8076>
- [2] Fraunhofer Institute for Solar Energy Systems, "Photovoltaics Report," Freiburg, Jul. 29, 2024. doi: <https://doi.org/10.26740/jte.v9n1.p%25p>
- [3] I. Yusuf and A. Hiendro, "Implementasi Water Cooling System Untuk Menurunkan Temperature Losses Pada Panel Surya". doi: <https://doi.org/10.26418/j3eit.v5i3.21994>
- [4] P. K. Tiyas and M. Widartono, "Pengaruh Efek Suhu Terhadap Kinerja Panel Surya," *Jurnal Teknik Elektro*, vol. 9 (1), 2020.
- [5] A. F. Nurhasanah, S. Sudarti, and Y. Yushardi, "Kajian Perubahan Iklim Terhadap Efficiency Panel Surya Sebagai Sumber Energi Alternatif di Indonesia," *Opt. J. Pendidik. Fis.*, vol. 7, no. 2, pp. 366–375, Dec. 2023, doi: <https://doi.org/10.37478/optika.v7i2.3284> .
- [6] W. Widjanarko, N. Alia, A. Dani, and F. A. Perdana, "Experimental analysis of temperature, light intensity, and humidity on rooftop standalone solar power plant," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1073, no. 1, p. 012047, Feb. 2021, doi: <https://doi.org/10.1088/1757-899X/1073/1/012047> .
- [7] S. Nizetić, M. Jurčević, D. Čoko, and M. Arıcı, "A novel and effective passive cooling strategy for photovoltaic panel," *Renew. Sustain. Energy Rev.*, vol. 145, p. 111164, Jul. 2021, doi: <https://doi.org/10.1016/j.rser.2021.111164> .
- [8] N. M. Janna and D. A. Widodo, "Analisis Karakteristik Modul Panel Surya Dengan Sistem Pendingin Air," *J. Fokus Elektroda Energi List. Telekomun. Komput. Elektron. Dan Kendali*, vol. 6, no. 1, p. 37, Feb. 2021, doi: <https://doi.org/10.33772/jfe.v6i1.16200> .
- [9] K. Ramadani. "Pengaruh Lama Waktu Penyemprotan Sistem Pendingin Water Spray Terhadap Kinerja Panel Surya." PhD diss., Universitas Islam Riau, 2022. <https://repository.uir.ac.id/11028>
- [10] M. Sobari, F. Antoni Putri, R. Wulandari, and A. Muhamad Toha, "Design of Solar Panel Cooling System Based on Natural Circulation Using Ground Source Energy," *Malays. J. Sci. Adv. Technol.*, pp. 290–295, Jul. 2024, doi: <https://doi.org/10.56532/mjsat.v4i3.345> .
- [11] D. Almanda and D. Bhaskara, "Studi Pemilihan Sistem Pendingin pada Panel Surya Menggunakan Water Cooler, Air Mineral dan Air Laut," *Resist. Elektron. KEndali Telekomun. Tenaga List. Komput.*, vol. 1, no. 2, p. 43, Nov. 2018, doi: <https://doi.org/10.24853/resistor.1.2.43-52> .
- [12] S. Krauter, "Increased electrical yield via water flow over the front of photovoltaic panels," *Sol. Energy Mater. Sol. Cells*, vol. 82, no. 1–2, pp. 131–137, May 2004, doi: <https://doi.org/10.1016/j.solmat.2004.01.011> .
- [13] R. A. Nanda, A. Gumelar, and D. Mulyadi, "Penggunaan dan Analisis Panel Surya Lepas Pantai Menggunakan Pipa Apung sebagai Media Apung," *J. Tek. Mesin Indones.*, vol. 19, no. 02, pp. 65–70, Sep. 2024, doi: <https://doi.org/10.36289/jtmi.v19i02.720> .
- [14] F. Wani, U. Shipurkar, J. Dong, and H. Polinder, "A Study on Passive Cooling in Subsea Power Electronics," *IEEE Access*, vol. 6, pp. 67543–67554, 2018, doi: <https://doi.org/10.1109/ACCESS.2018.2879273> .
- [15] G. Ananda, M. D. N. Hakim, and R. Wulandari, "Comparative Study by Experiment of Design Cooling System Between Air Cooling and Water Spray Cooling Method for Optimization of Solar Photovoltaic," *Indones. J. Innov. Appl. Sci. IJIAS*, vol. 4, no. 2, pp. 133–140, Jun. 2024, doi: <https://doi.org/10.47540/ijias.v4i2.1455> .
- [16] O. T. Laseinde and M. D. Ramere, "Efficiency Improvement in polycrystalline solar panel using thermal control water spraying cooling," *Procedia Comput. Sci.*, vol. 180, pp. 239–248, 2021, doi: <https://doi.org/10.1016/j.procs.2021.01.161> .
- [17] H. A. Kazem, M. T. Chaichan, A. H. A. Al-Waeli, and K. Sopian, "A review of dust accumulation and cleaning methods for solar photovoltaic systems," *J. Clean. Prod.*, vol. 276, p. 123187, Dec. 2020, doi: <https://doi.org/10.1016/j.jclepro.2020.123187> .