A floating photovoltaic system for fishery aeration

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Abstract. Photovoltaic panel as a producer of renewable energy is increasingly being utilized. The electrical energy produced by photovoltaic panel can be used for aeration in fish ponds located quite isolated and far from the main electricity grid. Aeration is important for fishery because it affects the dissolved oxygen level in the water. The system uses two units of 50 Wp floating solar panels and four units of DC aerator of 12 Volt/0.28 A. The measurement of solar irradiance, solar panel temperature, output voltage and current was conducted to monitor floating solar panel performance. Dissolved oxygen level measured in the water without aeration was 3 - 3.9 mg/L while after using floating photovoltaic panels to supply the electrical energy for aerators, dissolved oxygen level in the water was increased to 4.1 - 4.8 mg/L.

1. Introduction

The use of aerators in aquaculture is important in fish growth because it relates to the concentration of dissolved oxygen in the water [1]. With the increase in dissolved oxygen concentration in fish pond, the quality of the pond becomes healthier and fish productivity increases. The aeration system works by pushing air from the bottom up in the pond in the form of small bubbles that appear on the surface, making dissolved oxygen and temperature in the water the same [2].

The driving energy for the aerator itself can be sourced from electricity or mechanics [1]. The energy source that can be a solution for fish ponds located quite isolated and far from the main electricity grid is floating photovoltaic panels; however, there are a few challenges related to monitoring their performance [3-4]. Based on several existing studies, floating photovoltaic panel will produce better performance than photovoltaic panel on the ground [5-7].

Several studies about design and the use of photovoltaic panel as a source of aerator energy in fish ponds have been carried out in Philippines [8], Egypt [9], Jakarta [10], Southern South America [11] and Thailand [12]. In this study, 2 units of floating photovoltaic panels with a capacity of 50 Wp each were implemented as an energy source for aerators in the fish pond. In addition to seeing the performance of floating photovoltaic panels, it is also measured dissolved oxygen level produced from aerators that use power from floating photovoltaic panels. Several other related parameters of concern are the voltage and current generated from photovoltaic [13], solar irradiance at the site, photovoltaic panel surface temperature and water temperature in the fishpond.

2. Methodology

The energy from sunlight hitting the solar panels is converted to produce voltage and current. Rated voltage and current can be seen in the Solar Charger Controller (SCC). The power output of floating solar panels can drive a DC aerator. The excessive power generated will charge the battery. The existing Arduino is connected to the source and load, which will measure current and voltage produced. Completely, the block diagram can be seen in Figure 1.

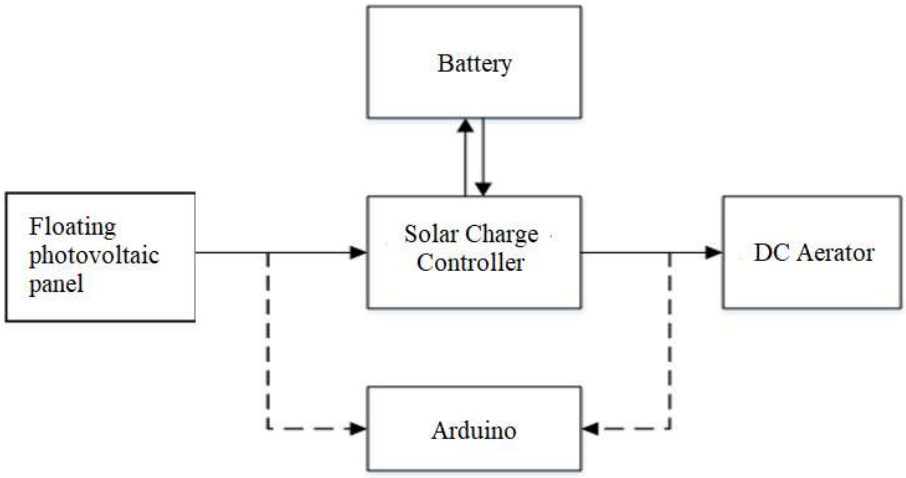


Figure 1. Block diagram of photovoltaic system

Figure 2 is floating photovoltaic panels with a total capacity of 100 Wp (2 units of 50 Wp solar panels) that use 4 inch PVC to float on water. The heatsink is placed under the solar panels whose tip is dipped in water. The sensors used for measurement are the solar radiation sensor placed on the panel and the water temperature sensor immersed in the water.

Figure 2. Design of floating photovoltaic panels

Figure 3 shows photovoltaic system which is implemented as an aerator energy source. The panels are floated on the edge of the pond. The power generated from the solar panels goes to the solar charge controller, which is then stored in the battery. After the battery is charged, power from the battery is used to turn on the aerator, producing oxygen. The sensors used include the INA219 sensor to measure the voltage and current from the panel and the load, the DS18B20 sensor to measure the temperature of the water, the GY-302 sensor to measure radiation from the sun and the DHT22 sensor to measure the panel temperature. The Arduino device used is Arduino Mega 2560.

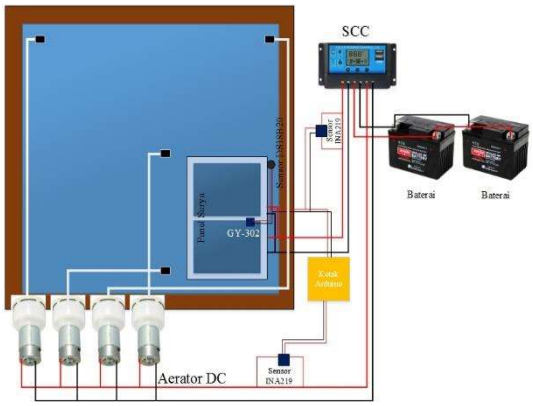


Figure 3. Floating photovoltaic panels as the energy source for DC aerators

3. Results and discussion

The photovoltaic panels used are two units with a capacity of 50 Wp each. The panels are used to convert solar energy into electrical energy which is stored in the battery before being used to power the aerator. Photovoltaic units used and their placement can be seen in Figure 4.

Figure 4. Floating photovoltaic panels

Figure 5 shows the solar irradiance value measured at the photovoltaic panels placement location. From the measurements, it can be seen that the maximum solar irradiance is 838 W/m^2 and a minimum of 36.8 W/m^2. The value of solar irradiance can provide information related to the potential power generated at that location.

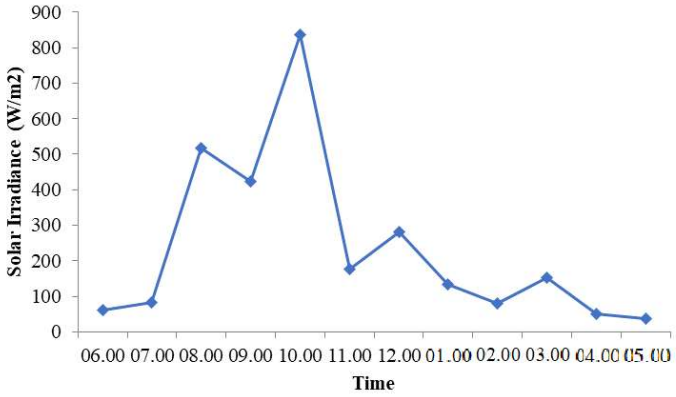
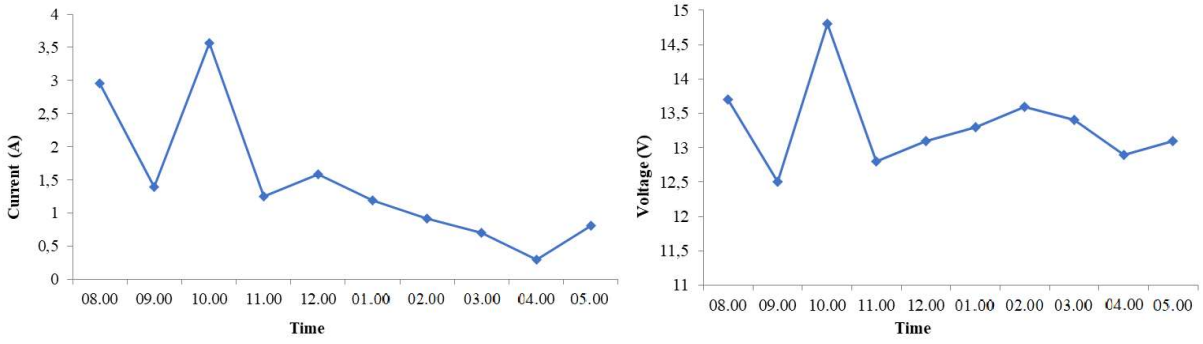


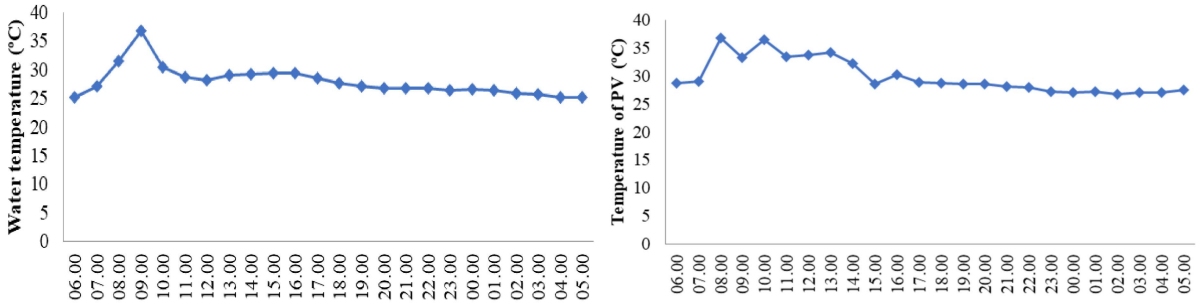
Figure 5. Solar irradiance



(a) **(b)**

Figure 6 (a) Current generated by floating photovoltaic panels
(b) Voltage generated by floating photovoltaic panels

Figure 6(a) shows the current measured using the INA219 sensor. Daily measurements were carried out from 08.00 a.m. to 05.00 p.m. The measured current varies, influenced by the condition of environmental parameters. The highest current measured is 3.56 A. Figure 6(b) is a graph of voltage generated by solar panels measured by INA219 sensor. Voltage data was monitored from 08.00 a.m. to 05.00 p.m. The highest voltage value generated is 14.8 V and the lowest is 12.8 V.



(a) (b)

Figure 7 (a) Water temperature in fish pond
(b) The surface temperature of photovoltaic panel

Figure 7(a) shows measurement values of water temperature in the fish pond from the DS18B20 sensor. From the measurements, it was found that the average temperature in the fish pond is 27°C. While in Figure 7(b), results from the DHT22 sensor measurement for photovoltaic panel surface temperature are shown. The highest temperature measured is 37°C. Both the surface temperature of the photovoltaic panels and the temperature inside the fish pond fluctuate due to the influence of weather conditions. The temperature of the photovoltaic panels is not high because the panels are floated in the fish pond and the solar irradiance is relatively low throughout the day.

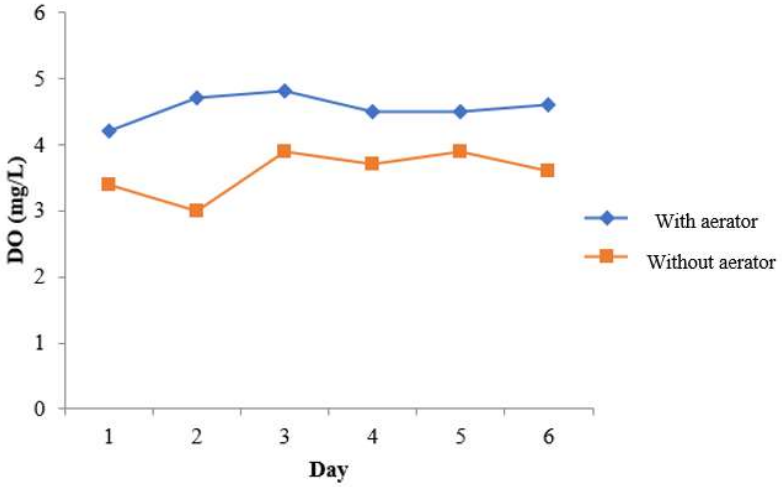


Figure 8. Dissolved oxygen (DO) level in the fish pond

In Figure 8, dissolved oxygen level looks significantly different with and without aerators. Dissolved oxygen level measurements in fish pond were carried out at the edge of the pond. Without aerators, the measured dissolved oxygen values are 3 - 3.9 mg/L. After using aerators whose electrical energy wassourced from floating photovoltaic panel, dissolved oxygen value increases to 4.1 - 4.8 mg/L.

4. Conclusion

The use of floating photovoltaic panel as a source of electrical energy to supply locations far from the primary power grid needs to be developed. One of its uses is as a source of electrical energy for aerators in fish ponds. It is seen that there is a significant increase in the dissolved oxygen value in the fish pond. There is an increase in dissolved oxygen value from 3 - 3.9 mg/L to 4.1 - 4.8 mg/L. This increase will certainly positively impact a healthy environment for fish to grow and develop properly.

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