Study on induced aeration for fishery fields using floating SPV

Sai Mounika Muramulla1*, Rangampeta Rajeshwari2, Rejina Parvin J3, Anand chakaravarthi M C4, Kedri Janardhana5, Sumanta Bhattacharya6
1Department of Zoology and Aquaculture, Acharya Nagarjuna University, University College of Sciences, Guntur, Andhra Pradesh 522510, India.
2Department of Zoology, Osmania University, Amberpet, Hyderabad, Telangana 500007, India.
3Department of Electronics and Communication Engineering, Sri Krishna College of Engineering and Technology, Kuniyamuthur, Coimbatore, Tamil Nadu 641008, India.
4Department of Mechanical Engineering, Sri Sairam Engineering College, Sai Leo Nagar, West Tambaram Poonthandalam, Village, Chennai, Tamil Nadu 602109, India.
5Department of Electrical Engineering, Dayalbagh Educational Institute (Deemed University), DayalBagh, Agra, Uttar Pradesh 282005, India.
6Department of Textile Technology, Maulana Abul Kalam Azad University of Technology, Bidhannagar, Kolkata, West Bengal 700064, India.

*Corresponding author: saimounika052@gmail.com

Abstract. The soluble oxygen content in the water is affected by oxygenation, which is a vital factor for commercial fishery fields. The soluble oxygen content is the prime factor for the fishes grown in those fields, and most probably, the fields are located in remote locations where electricity could not be accessible. Photovoltaics (PVs) are becoming more popular as a renewable resource. The electric power generated by solar panels can be utilized to run the aerators in order to aerate the fishery fields that are isolated and disconnected from the primary power system. A 100 Wp floated solar PV (SPV) modules for powering five numbers of DC aerators are used in the present investigation. The efficiency of floated solar panels was monitored by measuring sun irradiation, PV temperatures, output power, and current. The amount of oxygen in the water before aeration was around 3.2 mg/L, however after deploying floated solar panels and aerator, the level of soluble oxygen was raised to 4.4 mg/L.

Keywords: Floating SPV; aerator; fishery field; dissolved oxygen; solar PV.

1. Introduction
India is among the world's most populous countries in farming as well. Fisheries accounts for a significant component of the economic growth, and the civilization and ingestion of marine items serve significant roles [1]. Aquaculture must find the most value from limited natural resources, which leads farming professionals to produce large quantities of aquacultural farms. Whenever the climate abruptly varies, it is quite possible to induce oxygen deprivation in fishes and perhaps even fatality [2]. Because the proportion of oxygen in the water affects fish development, the use of aerator in aquacultures is critical [3, 4]. The condition of the lake improves and fish production rises as the solubility of oxygen in the fish farm is up to the mark. The oxygenation systems work by forcing airflow from bottom of a lake to the top in the form of tiny bubbles, maintaining the same level of free oxygen and water temperatures [5, 6]. The fish farming aerator delivers enough air for large fishponds...
while also making complete utilization of the water to allow faster substance movement in the tank [7]. This could efficiently prevent fish deaths due to inadequate oxygen availability in large farms [8, 9]. Furthermore, it can both enhance and stabilize quality of the water.

The supply of energy is inextricably linked to the explosive growth of the fisheries. An aerator’s propelling power can come from either electrically or mechanically. The typical fish farming aerating device is powered by conventional energy that should be linked to the electrical network [10, 11]. However, fish farming is mostly concentrated on the fringes of poorly inhabited farm fields, which complicates the electricity supply of fish farming aerators [12, 13]. The standard fish farm air delivery system is not just to utilizes higher energy, but also become costlier. It also has the drawbacks of being difficult to connect to the electricity network and consuming troublesome electricity. Using sun's radiation as the source of power for aquacultural equipment can help to guarantee, that fish farming runs smoothly [14, 15]. It has a wide range of applications. Utilizing energy from the sun as a source of electricity for aerating equipment for fish farms and building appropriate aerators for fishing fields to improve fisheries mechanization and raise fishers' financial benefits. The construction of a solar based aerating equipment for a fish farm may increase the use of renewable radiation in aquaculture output while also increase the financial advantage and competitiveness in the outside market of the fisheries. Float type solar photovoltaics (SPV) are an energy sources that might be the solutions for fish farms that are separated and remote from the primary electrical grid; nevertheless, there are certain issues with controlling their efficiency [16, 17]. According to the various researches, floated solar panels perform better than ground-mounted SPVs [18, 19].

Many researches have been carried out around the world on the designing and usage of solar panels as sources of aerator’s energy in fishery fields [20, 21]. A unit of a floated SPV, with a capacity of 100 Wp had been used as a power source for aerating machines in the fish farm in this study. It is also monitored the oxygen content created by aerator that use electricity from floated SPVs, in addition to the efficiency of floated photovoltaics. The current produced by photovoltaics, solar irradiation at the location, photo voltaic surface temperatures, and water temperatures in the fish farm are all important characteristics to be concerned about the healthy fishery field and hence, they are considered in this present study.

2. Methodology

![Diagram showing connections of various parts.](image_url)
The daylight that strikes the solar panel is transformed into current and voltage. A Solar Charging Controller displays the allowed voltage and currents. A DC aerator of capacity $25 \text{ cm}^3$ of air per sec may be powered by the electrical outputs of floating solar panels. The battery will be charged by the surplus power generated. The sources and load are linked to the Arduino control board, which will analyze the currents and voltage generated. Figure 1 shows a drawing of the connections.

Figure 2 shows schematic arrangement of floated SPVs which has made float over the fishery field with the aid of floats [22, 23]. The heat sink is positioned beneath the water-dipped solar panels. The solar irradiation sensor and the water temperatures sensor are the detectors used for measurements.

The panel is floating over the fishery field’s surface, using the cost efficient floaters. The solar panel creates electricity, which is sent to the solar panels and then accumulated in the battery. After the batteries have been loaded, the battery’s electricity is utilized to flip on the aerators, which produces oxygen. The dedicated sensors were used to evaluate the voltages and current in between SPV and the loads, the temperature sensor measures the temperature of the SPV panel as well as water, and the TES-1333 sensor (accuracy of $\pm 20 \text{ W/m}^2$) is used to measure solar radiation [24, 25]. The Arduino board was utilized in this project for the controlling mechanisms.

3. Results and discussion

![Solar irradiance](image-url)
As mentioned in the earlier section, a SPV panel of 100 W was employed to generate the required amount of electricity. Sun power is converted into electric energy by the SPV panel, which is then collected in the battery until being utilized to fuel the aerators. The sun irradiance values observed during the presence and absence of the SPV panels is shown in Figure 3. According to the observations, the highest solar irradiation is 990 W/m$^2$ and the least is 120 W/m$^2$. The values of solar irradiance may be used to calculate the amount of possible electricity generated at a certain place.

The voltage recorded with the voltage sensor is seen in the Figure 4. From 9 a.m. to 6 p.m., voltage data was recorded. 14.2 V was the greatest voltage created, and 12.6 V was the lowest. Figure 5 shows a graph of solar cell current as recorded by the current sensor. Starting from 9 a.m. until 6 p.m., everyday measurement was made. The actual current fluctuates depending on the state of environment variables. 3.8 Amp was the maximum current observed.

![Figure 4. Disparity in SPV voltage throughout the day.](image)

![Figure 5. Disparity in SPV current throughout the day.](image)
Figure 6 displays the measurements of temperature of the water in the fishing field. The average temperatures of the fish farm were found to be 30°C based on the readings. The result of the temperature sensors measurement for photovoltaic surface temperatures is also displayed in Figure 6. The hottest temperature recorded was 34°C. Owing to the effect of outside climate, both surface temperatures of SPV and the temperatures inside the fish farm changed. Since SPV are floating in the fish farm, the temperatures of the panels are less in spite of higher solar irradiation throughout the day.

Figure 6. Disparity in temperature throughout the day.

Figure 7 shows how levels of dissolving oxygen differ dramatically with and in the absence of aerator. The oxygen concentration in the fish farm was measured near the water surface levels. The
observed dissolving oxygen levels without aerator are 3.2 mg/L. The amount of dissolving oxygen in the water rises to 4.4 mg/L after utilizing aerator powered by a floating solar panel.

4. Conclusion
It is necessary to create the usage of floating solar panels being the energy source to feed regions situated in remote location. One of the applications is as an electricity source of aerator in the fishery fields. The dissolving oxygen levels in the fish fields have increased significantly. The dissolving oxygen value has increased from 3.2 mg/litre to 4.4 mg/litre. This growth will undoubtedly promote the pleasant condition in which fish may live and thrive appropriately.

References
[1] Prasetyaningsari, I., Setiawan, A. and Setiawan, A.A. 2013. Design optimization of solar powered aeration system for fish pond in Sleman Regency. Yogyakarta by HOMER software. Energy Procedia 32:90-98.
[2] Li, W., Wu, H., Zhu, N., Jiang, Y., Tan, J. and Guo, Y. 2021. Prediction of dissolved oxygen in a fishery pond based on gated recurrent unit (GRU). Information Processing in Agriculture 8(1):185-193.
[3] Sudhakar, M., Prasad, R., Ravinthiran, A., Dutt, P. and Chakavarthi, M.A. 2019. Performance improvement of trough concentrating photovoltaic thermal system: a review. Materials Today: Proceedings 16:647-652.
[4] Kumar, P.M., Chauhan, P., Sharma, A.K., Rinawa, M.L., Rahul, A.J., Srinivas, M. and Tamilarasan, A. 2022. Performance study on solar still using nano disbanded phase change material (NDPCM). Materials Today: Proceedings. doi.org/10.1016/j.matpr.2022.01.050
[5] Boyd, C.E., Torrans, E.L. and Tucker, C.S. 2018. Dissolved oxygen and aeration in ictalurid catfish aquaculture. Journal of the World Aquaculture Society 49(1):7-70.
[6] Balaji, M., Dinesh, S.N., Kumar, P.M. and Ram, K.H. 2021. Balanced Scorecard approach in deducing supply chain performance. Materials Today: Proceedings. doi: 10.1016/j.matpr.2021.05.541
[7] Balaji, M., Dinesh, S.N., Raja, S., Subbiah, R. and Kumar, P.M. 2021. Lead time reduction and process enhancement for a low volume product. Materials Today: Proceedings. doi.org/10.1016/j.matpr.2021.12.240
[8] Thirumalai, R., Senthilkumaar, J. S. 2013 Multi Criteria Decision Making in the selection of machining parameters for Inconel 718. Journal of Mechanical Science and Technology 27 (4):1109-1116.
[9] Kumar, P.M. and Mylsamy, K. 2020. A comprehensive study on thermal storage characteristics of nano-CeO2 embedded phase change material and its influence on the performance of evacuated tube solar water heater. Renewable Energy 162:662-676. doi.org/10.1016/j.renene.2020.08.122
[10] Puthilibai, G., Singaravelu, D.K., Dinesh, C., Chitradevi, S. and Sudhakar, M. 2021. Experimental investigation regarding emissivity of black nickel coated on aluminium surface. Materials Today: Proceedings 37:248-251.
[11] King, M.F.L., Rao, P.N., Sivakumar, A., Mamidi, V.K., Richard, S., Vijayakumar, M., Arunprasad, K. and Kumar, P.M. 2021. Thermal performance of a double-glazed window integrated with a phase change material (PCM). Materials Today: Proceedings. doi.org/10.1016/j.matpr.2021.09.099
[12] Kaushik, N., Saravanakumar, P., Dhanasekhar, S., Saminathan, R., Rinawa, M.L., Subbiah, R., Sharma, R. and Kumar, P.M. 2021. Thermal analysis of a double-glazing window using a Nano-Disbanded Phase Changing Material (NDPCM). Materials Today: Proceedings. doi.org/10.1016/j.matpr.2021.11.537
[13] Balaji, M., Dinesh, S.N., Vetrivel, S.V., Kumar, P.M. and Subbiah, R. 2021. Augmenting agility in production flow through ANP. Materials Today: Proceedings.
[14] Nandhakumar, S., Thirumalai, R., Viswaaswaran, J., Senthil, T.A., Vishnuvardhan, V.T. 2021. Investigation of production costs in manufacturing environment using innovative tools. Materials Today: Proceedings, 37:1235-1238.

[15] Mohan Kumar, A., Rajasekar, R., Manoj Kumar, P., Parameshwaran, R., Karthick, A. and Muhibullah, M. 2021. Comparative analysis of drilling behaviour of synthetic and natural fiber-based composites. Advances in Materials Science and Engineering 2021. doi.org/10.1155/2021/9019334

[16] Ramya, D., Krishnakumari, A., Dineshkumar, P.T., Srivastava, M.P., Kannan, L.V., Puthilibai, G. and Kumar, P.M. 2021. Investigating the influence of nanoparticle disbanding phase changing material (NDPCM) on the working of solar PV. Materials Today: Proceedings. doi.org/10.1016/j.matpr.2021.11.419

[17] Dinesh, S.N., Ravi, S., Kumar, P.M., Subbiah, R., Karthick, A., Saravanakumar, P.T. and Pranav, R.A. 2021. Study on an ETC solar water heater using flat and wavy diffuse reflectors. Materials Today: Proceedings. doi.org/10.1016/j.matpr.2021.05.561

[18] Sulaeman, S., Brown, E., Quispe-Abad, R. and Müller, N. 2021. Floating PV system as an alternative pathway to the amazon dam underproduction. Renewable and Sustainable Energy Reviews 135:110082.

[19] Kumar, P.M., Mukesh, G., Naresh, S., Nitthilan, D.M. and Kumar, R.K. 2021. Study on performance enhancement of SPV panel incorporating a nanocomposite PCM as thermal regulator. In Materials, Design, and Manufacturing for Sustainable Environment 587-597. doi.org/10.1007/978-981-15-9809-8_44

[20] Kumar, P.M., Anandkumar, R., Sudarvizhi, D., Prakash, K.B. and Mylsamy, K., 2019, July. Experimental investigations on thermal management and performance improvement of solar PV panel using a phase change material. In AIP Conference Proceedings 2128(1):020023. doi.org/10.1063/1.5117935

[21] Liu, H., Krishna, V., Lun Leung, J., Reindl, T. and Zhao, L. 2018. Field experience and performance analysis of floating PV technologies in the tropics. Progress in Photovoltaics: Research and Applications 26(12):957-967.

[22] Mohankumar, D., Pazhaniappan, Y., Kumar, R.N., Ragul, R., Kumar, P.M. and Babu, P.N. 2021. Computational study of heat-transfer in extended surfaces with various geometries. In IOP Conference Series: Materials Science and Engineering 1059 (1):012055. IOP Publishing. doi.org/10.1088/1757-899X/1059/1/012055

[23] Kumar, P.M., Arunthathi, S., Prasanth, S.J., Aswin, T., Antony, A.A., Daniel, D., Mohankumar, D. and Babu, P.N., 2021. Investigation on a desiccant based solar water recuperator for generating water from atmospheric air. Materials Today: Proceedings 45:7881-7884. doi.org/10.1016/j.matpr.2020.12.506

[24] Gunasekaran, N., Kumar, P.M., Raja, S., Sharavanan, S., Avinas, K., Kannan, P.A. and Gokul, S. 2021. Investigation on ETC solar water heater using twisted tape inserts. Materials Today: Proceedings. doi.org/10.1016/j.matpr.2021.04.586

[25] Boobalakrishnan, P., Kumar, P.M., Balaji, G., Jenaris, D.S., Kaarthik, S., Babu, M.J.P. and Karthihk, K., 2021. Thermal management of metal roof building using phase change material (PCM). Materials Today: Proceedings. doi.org/10.1016/j.matpr.2021.05.012