International Journal of Science, Environment and Technology, Vol. 5, No 5, 2016, 2921 – 2925
ISSN 2278-3687 (O)
2277-663X (P)

A CONCEPTUAL APPROACH FOR DEVELOPMENT OF SOLAR POWERED AERATION SYSTEM IN AQUACULTURE FARMS

Mohammad Tanveer[1] and Sivakumar Mayilsamy[2]
[1]Department of Aquaculture Engineering,
[2]Department of Basic Engineering,
College of Fisheries Engineering,
Tamil Nadu Fisheries University, Nagapattinam-611001, India
E-mail: nobletanveer@gmail.com (*Corresponding Author*)

Abstract: water and energy are interrelated as transportation, treatment, distribution and use of water depends on cost of operation; basically cost incurred on energy spent. Energy generation requires large volumes of water. Therefore, we need to use energy in a justifiable manner. Artificial aeration to the aquaculture pond water is a mature technology for maintaining dissolved oxygen (DO) content. But it is essentially a trade of energy for freshwater and brackishwater ponds and is not a viable solution for regions where both water and energy resources are depleting. Moreover, solar powered aeration systems can be implemented in the areas where abundant sun light is available. Therefore, in this paper a conceptual approach for the development of a solar powered aeration system for aquaculture farms has been discussed.
Keywords: Energy, artificial aeration, dissolved oxygen.

Introduction

Artificial aeration is used to increase the DO concentration in pond water. A properly designed aeration system is essential to maintain adequate and continuous supply of DO to meet the demand of the aquatic species. The rapid advancements of aeration technology, mostly electrical power is used to run the aeration systems mainly; paddle wheel aerator, or air blower etc. But due to rapid growth of population and depletion of water bodies there is a need to justifiable use of electrical power which is available at affordable cost. A major problem associated with electricity driven aeration units is high energy consumption. The aeration system uses the highest amount of power in any aquaculture farm. Based on the geographical location, fish ponds are generally located away from power lines. Therefore, it is necessary to use local potentials of renewable energy such as solar energy. The annual average solar radiation in India is 18- 20 MJ/m^2/day with 9% monthly variation (Chandal *et al*., 2005). The sun is a clean and renewable energy source, which produces neither green house effect gases nor hazardous wastes through its utilization. Renewable energy sources are

*Received Aug 9, 2016 * Published Oct 2, 2016 * www.ijset.net*

being widely used due to the global environment issue. To address this problem, a conceptual approach has been made to develop cost-effective aeration system and use solar energy instead of traditional energy sources to power the system operation (Weiner *et al.* 2001; Kershman *et al.* 2002; Liu *et al.* 2002; Keeton Jr., 2004).

Components of solar powered aeration system:

- Photovoltaic solar panels
- DC converter
- Solar batteries
- Aerator
- Power/Energy meter

- **Photovoltaic (PV) solar panels:** PV panels, which cost anywhere from Rs 30 to Rs 60 per watt of power generated. Ministry of New and Renewable Energy (MNRE) provides 30% capital subsidy on capital expenditures for rooftop solar systems for both commercial and residential entities for systems up to 100 kW. The government also provides loans at 5% per annum for 50% of the capital expenditure for 5 years tenure for both commercial and residential entities (MNRE, 2016).
- **DC-to-AC inverters:** Inverter is an electricity tools used for converting the direct current (DC) to alternating current (AC). The inverter converts the DC current from the battery. Inverters take the low-voltage, high-current signals from the PV panels and convert them into 120VAC (or 240 VAC), which is directly compatible with grid power. Inverters cost around Rs-50 to Rs 95 per watt for a typical application.
- **Storage Batteries:** The storage batteries store the electrical power in the form of a chemical reaction. The battery consists of reversible electrochemical cell and has a good efficiency. Without storage we would only have power when the sun is shining or the generator is running.
- **Aeration unit:** An aerator may be paddle wheel or spiral type is chosen as per the requirement and size of aquacultural pond.
- **Power/Energy meter:** A power meter is used to keep an eye on power consumed by the system.

The proper wires and cables will of course be required to connect every component of the solar powered aeration system. Depending on system size, total cost of the aeration unit will vary.

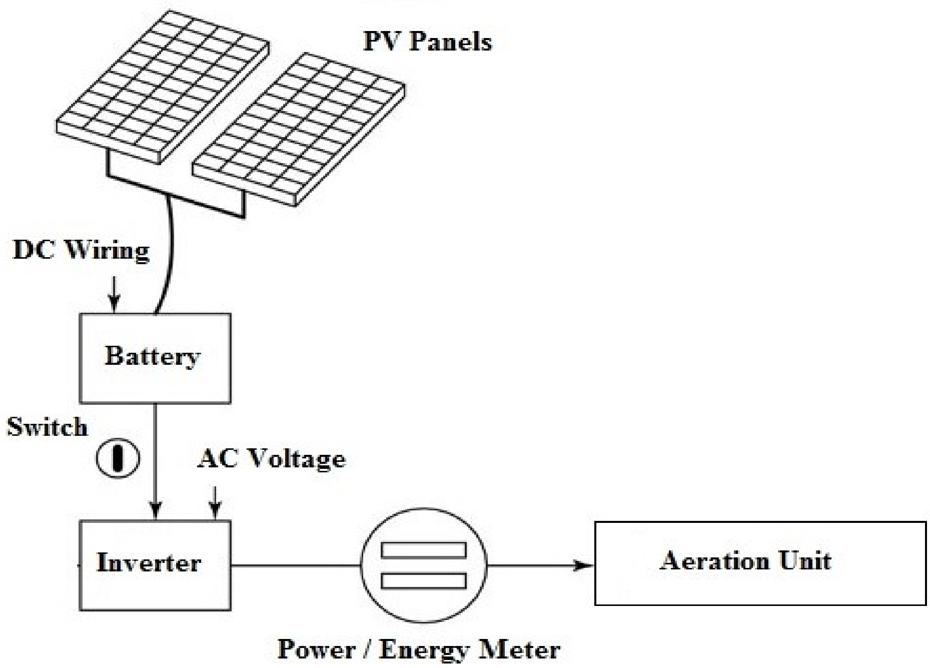

Figure 1. Schematic diagram of solar powered aeration system

There are certain fundamental advantages and limitations using solar energy are as follows:

Advanatages:

- No emission of green house gases.
- It is available absolutely free of cost.
- It offers decentralization of power.
- It can be produced on or off the grid.
- It saves ecosystem and climate.
- As there are no moving parts in a solar panel, they require very little maintenance.

Limitations:

- It can only be captured during day time.
- Solar energy production is relatively inefficient.
- Solar panels and batteries are bulky.
- Generally solar panels can convert only a maximum of 34% of the available sunlight into electrical energy, although more efficient panels are being developed.

System Modeling and Energy Calculations:

Total Load: The load demand of a fish pond can be calculated based on the aeration, indoor and outdoor lighting, pumping, feeding and other related work using energy utilities like electronic monitoring devices and controlling devices. This is achievable based on the empirical formulae with the predetermined or Catalog values of the efficiencies of the individual systems.

Total Load = $\sum E_{demand} / [\eta_{bat} \times \eta_{inv} \times \eta_{wiring} \times \eta_{aerator} \times \eta_{pumping}]$ (1)

Solar Panel: Capacity of the Solar panel can be derived using the assumed or stipulated value of adaption factor AF [I Prasetyaningsari et al. 2013] using the equation 2.

$Ps = [\sum E_{demand} / E_{sun}] \times AF$ where E_{sun}=Solar insolation (kWh/m^2/day), (2)

Inverter: Inverter input can be calculated through equation 3.

$C_{inverter} = P_{Peak} \times \eta_{inv}$ where P_{Peak} is peak power of the system in kW (3)

Conclusions

The adoption of this technology to a fish farmer needs an intense communications among stakeholder to avoid miscommunication and to accelerate the execution of the technology. The technology transfer needs cosmopolitans who understand people, culture and infrastructure in developing countries as discussed by Murai (2000). The community needs to assist by local people where solar powered projects in aquaculture farms be implemented. The role of local people is to assist the public in scientific and sociological aspect. The involvement and interest of local people in the adaptation technology for a fish farmer improve the process of communication among the stakeholder. Good and effective communication among stakeholder provides an example of a successful technology transfer.

Nomenclature:

$\sum E_{demand}$ = Electrical Load

η_{bat} = Efficiency of the Battery (%)

η_{inv} = Efficiency of the Inverter (%)

η_{wiring} = Wiring Efficiency (%)

$\eta_{pumping}$ = Pumping Efficiency (%)

E_{sun}=Solar insolation (kWh/m^2/day)

AF = Adoption Factor

P_{Peak} = peak power of the system in kW

$C_{inverter}$ = Inverter input in kW

Acknowledgement

The authors are thankful to College of Fisheries Engineering, Tamil Nadu Fisheries University for motivation towards research.

References

[1] Appelbaum, J, Mozes D. Steiner, A. Segal, I., Bark, M., Reuss, M., and Roth, P.(2001). Aeration of fish-ponds by photovoltaic power. *Progress in Photovoltaics*, 9: 295-301.

[2] Chandal, S.S., Agarwal, R.K. and Pandey, A.N. (2005). New correlation to estimate global solar radiation on horizontal surface using sunshine hours and temperature data for Indian cities, *Jour. of Solar Energy Engineering*, 127, 417-420.

[3] http://www.mnre.gov.in/information/manufacturesindustriesarchitectsconsulting-organisation/, accessed on February 12, 2016).

[4] Keeton, Jr J. A., "Solar aeration system," US Patent 6676837 B2, January 13, 2004.

Liu, Y.H. and Jordan, R.C. (1960).The inter relationship and characteristic distribution of direct, diffuse and total solar radiation from metrological data, *Solar Energy*, 4, 1-19.

[5] Meah K, Fletcher S, and Ula S. (2008). Solar photovoltaic water pumping for remote location. *Renewable and Sustainable Energy Reviews*; 12:472-87.

[6] Murai, S. (2000). Technology transfer for sustainable development in developing countries. *International Archives of Photogrammetry and Remote Sensing.* Vol. XXXIII, Part B6. Amsterdam.

[7] 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.

[8] Setiawan, A. and Setiawan, A.A. (2012). "Community Development in Solar Energy Utilization to Support Fish Farming in Sendangsari Village". International Conference on Sustainable Energy Engineering and Application, Yogyakarta.