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Performance Evaluation of Solar Photovoltaic Water Pumping System

L. Aiswarya[1*], K. Arunadevi[2], R. Lalitha[2] and S. Vallalkannan[3]

[1]Agricultural Engineering College and Research Institute, Kumulur, Tamil Nadu, India
[2]Department of Soil and Water Conservation Engineering and Agricultural Structures,
[3]Department of Applied Sciences and Engineering, AEC &RI, Kumulur, Tamil Nadu, India

**Corresponding author*

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A B S T R A C T

Solar photovoltaic water pumping system is becoming an important alternative for reducing the usage of fossil fuels and electricity to a large extent. The performance of the photovoltaic (PV) water pumping system situated at Central Farm of AEC&RI, Kumulur, Tamil Nadu (Latitude: 10.93N, Longitude: 79.82E) had been studied. A 5hp DC motor with 3750W (15 panels of each 250W) had been used for a discharge of 20 m head. The system was tested for its performance in terms of variation in discharge due to change in solar output power. It was observed that the PV output power changes from 2435 to 3688 lux at noon conditions. Maximum discharge of 7.33 litres per second was obtained at the time of 2PM. It was observed that pump discharge increased with the output power.

Introduction

Utilization of renewable energy sources for water pumping is becoming more profitable despite of the initial cost of installation and useful for the remote areas where electrification for running conventional water pumps is not possible. India receives solar energy of 5000 trillion KWh/yr with daily average solar energy incidence of around 4to7KWh/m^2. Most of the states receive about 250 to 300 sunny days. So, using solar energy for water pumping is getting an eco-friendly and green way alternative. Solar energy is considered to be cleaner and cheap source compared to other energy sources. The solar energy can be harnessed by the help of photovoltaic system. The basic principle behind this system is the photovoltaic effect which converts the sunlight hitting the panels into electricity. During summer season, the water requirement is more and also solar energy was plenty enough to meet the demand.

Abu Aligah (2011) compared photovoltaic water pumping system with the diesel powered pump. They observed that the efficiency of the solar pump depends on the design of solar panel and were more reliable than diesel pump. Pawan Kumar *et al.*, (2013) analysed the performance of photovoltaic based submersible pump in Rajasthan Technical University Kota. They found out that the discharge was more than the prescribed discharge of 50000 litres per day as

the system was installed at 30m instead of the designed 50m.Foster *et al*., (2014) stated that the performance of the solar PV pump depends on the water flow rate which was influenced by weather conditions at the locations, especially solar intensity and air temperature variations. Korpale *et al*., (2015) assessed the performance of solar agricultural water pumping system in Institute Of Chemical Technology, Mumbai. They found that the maximum discharge obtained with maximum solar intensity and the efficiency of solar pump was increased to 39% by using the MPPT controllers. Priyanka *et al*., (2018) evaluated the performance of a solar water pumping system in College Of Agricultural Engineering, Karnataka. They stated that the power output from the solar array increases as solar intensity increases and pumping efficiency of 66.07% was obtained at the noon conditions.

Materials and Methods

The system consists of solar panels, mounting structures, pump and controller. The solar photovoltaic panel consists of 15 panels of 250W each were used to generate the power to run motor (DC) pump. The Vmpp (Maximum Power Point Voltage) and Impp (Maximum Power Point Current) of the panels were 36.99V and 8.65A respectively.

The mounting structures can be either fixed or tracking type (single axis / double axis). The power efficiency of the single axis and double axis were 13% and 25% respectively more than that of the fixed mount (Deepthi *et al.*, 2013). In this study, single axis tracking mounting structure and 5hp submersible pump at 20m head were used. The controller uses the solar electricity produced on site to run the pump. The functions of the pump controller were as follows:

1. Panel reverse polarity protection: The controller protects the PV panel against the reverse polarity condition.
2. Overload protection: Controller will turn off the pump if it gets overloaded.
3. Dry run protection: The controller will start the pump automatically after 20minutes if water level increases.
4. Short circuit protection: In the case of a short circuit in motor winding or in the connecting wires, the controller will automatically turn off the pump

Orientation and direction of the PV array

The orientation of the solar panel is one of the important factors determining the efficiency of the Solar PV water pumping system. For northern hemisphere, the solar panels were kept south facing as they are exposed to the sun for the maximum day hours.

Since the solar photovoltaic system was tracking the sun in a single axis, the system was able to harness the solar energy always during day time to produce the required power to run the motor. The optimum tilt angle of the solar PV system is equal to the latitude of the study area (Raghavendra *et al*., 2018) and was 10 degree.

The experiment was conducted at the Central Farm of the Agricultural Engineering College and Research Institute, Kumulur, Tamil Nadu (Plate 1). The study area is located on the latitude of 10.93º N and longitude of 79.82º E.

Measurements of the voltage, current and power

The voltage, current and the power produced by the PV array was recorded every hour from 10:00am to 5:00pm. Relation between the voltage, current and power with the time were studied.

Measurements of light intensity, temperature and relative humidity

The light intensity was measured by the Lux meter and temperature and relative humidity readings were taken by the humidity-temperature meter. The readings were recorded every hour from 10:00am to 5:00pm.

Discharge of the pump

The discharge of the solar pump is the volume of water delivered by the pump in unit time (litre per second).

It was calculated volumetrically by collecting water in a 25litre container and note down the time taken to fill up the container by using the stopwatch. The same was repeated for five trails and the averages of the trails were considered.

Results and Discussion

The performance of the solar photovoltaic based water pumping system was evaluated from 10:00am to 5:00pm. The different parameters were compared to understand the influence of each in the performance of the pump and are plotted as graphs below:

It was observed that during morning condition (when light intensity is low), power increased about 22.1% from 1770.21 to 2271.47watts. The power produced from the PV array was dependent on the incident light intensity.

During noon conditions (when light intensity is high), the power increment was about 34% (from 2435.16 to 3688.25 watts) and got a maximum discharge of 7.33 litres per second for a light intensity of 765 lux (Fig. 1–7).

Fig.1 Components of the solar PV water pumping system

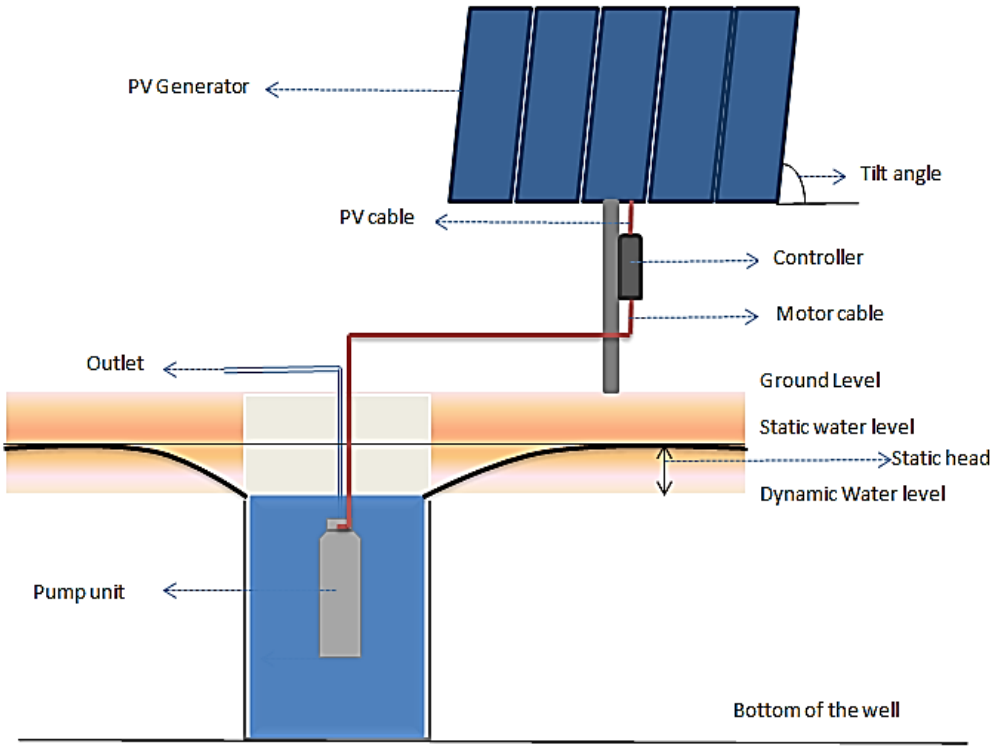


Plate.1 Solar PV water pumping system at central farm

Fig.2 Variation of voltage with respect to light intensity

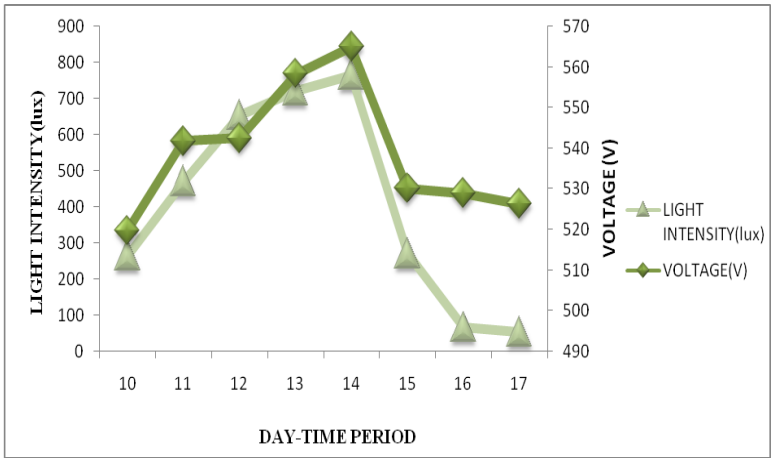


Fig.3 Variation of current with respect to light intensity

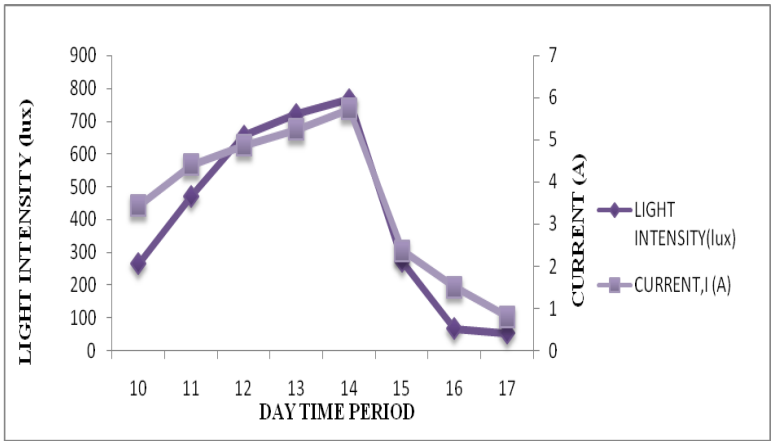


Fig.4 Variation of power with respect to light intensity

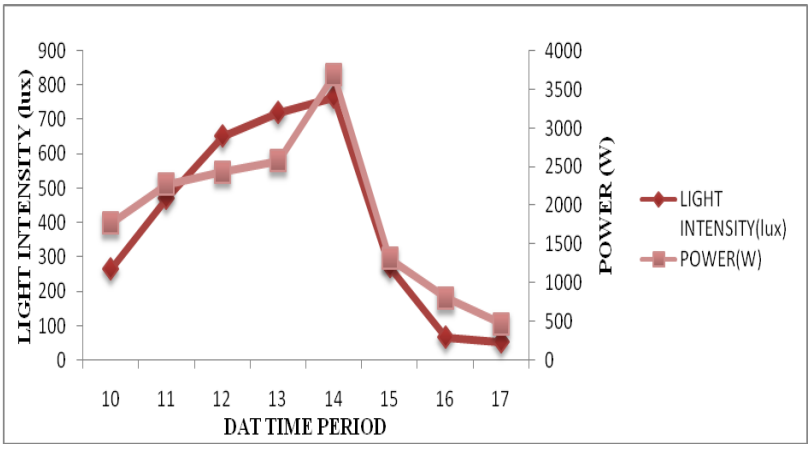


Fig.5 Variation of temperature with respect to light intensity

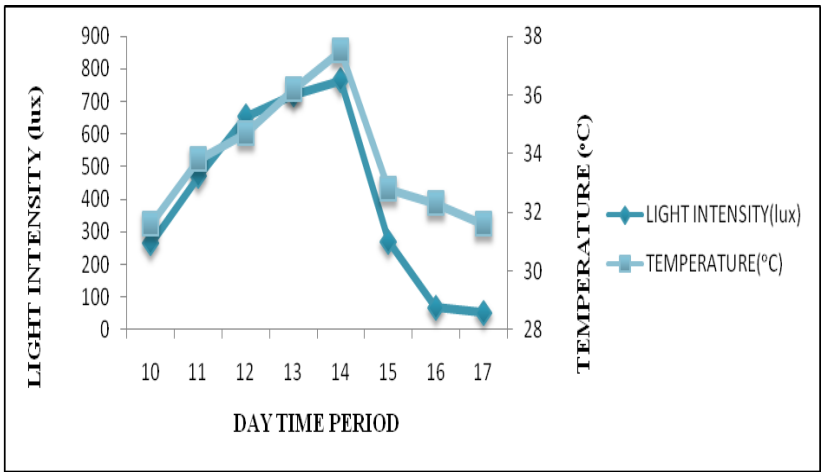


Fig.6 Variation of relative humidity with respect to light intensity

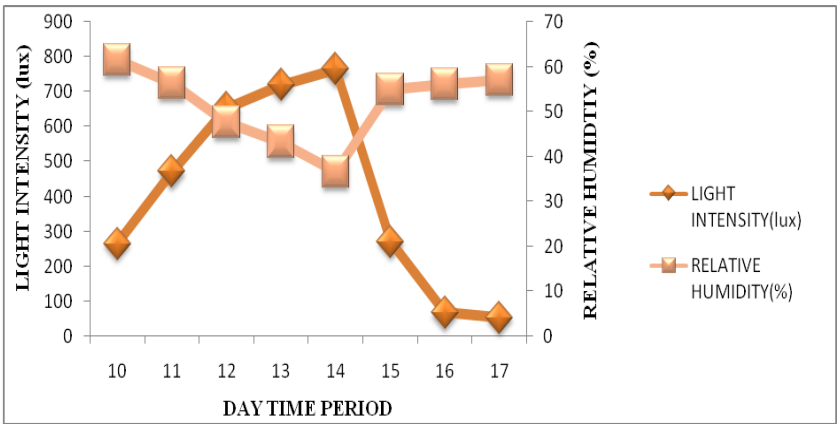
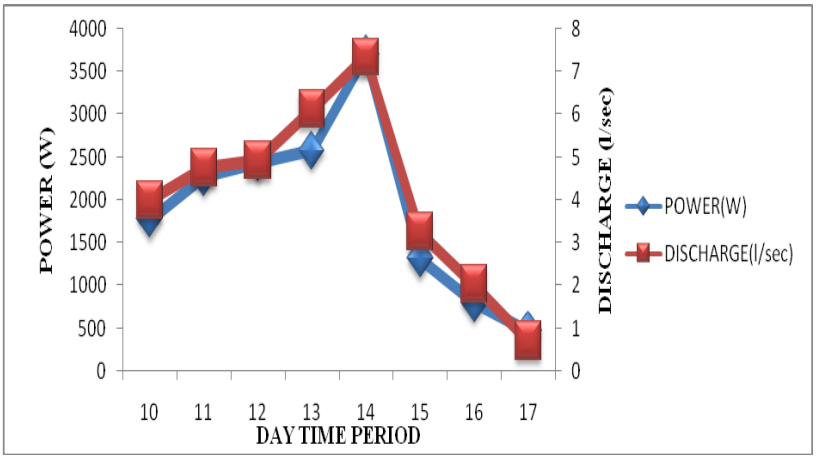


Fig.7 Variation of discharge with respect to power



Increment of voltage and current were 3.9% and 15% respectively.

It was observed that the discharge was increased from morning to noon after that discharge decreased to 0.71l/sec. This is due to, the power got dropped about64% as the voltage and current were decreased to 0.7% and 66% respectively.

The power output of the solar water pump depends upon the light intensity. As the intensity increases, the pumping power also increases thereby getting more discharge. Thus we can utilise this solar water pumping system at the time of higher water demand.

References

Deepthi, S., Ponni, A., Ranjitha, R., and Dhanabal, R. (2013). Comparison of Efficiencies of Single-Axis Tracking System and Dual-Axis Tracking System with Fixed Mount, *2*(2), 425–430.

Raghavendra, V., Palled, V., and Veerangouda, M. (2018). Performance Evaluation of Solar Water Pumping System, *7*(5), 133–142.

Hassan, A. B., and Muhammadu, M. M. (2012). Design, construction and Performance Evaluation of a Solar Water Pump, *2*(4), 711–718.

Korpale, V. S., Kokate, D. H., and Deshmukh, S. P. (2016). Performance Assessment of Solar Agricultural Water Pumping System. *Energy Procedia*, *90*(December 2015), 518–524. https://doi.org/10.1016/j.egypro.2016.11.219.

Lal, S., Kumar, P., and Rajora, R. (2013). Performance analysis of photovoltaic based submersible water pump, *5*(2), 552–560.

Raghavendra, V., Palled, V., and Veerangouda, M. (2018). Performance Evaluation of Solar Water Pumping System, *7*(5), 133–142.

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