International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com
Vol. 22, No. 1, 2026

Research Paper

SOLAR WATER PUMP FOR DOMESTIC USE

[1] Mr.T.Gurumurthy, [2] Telagamalla Vamshi, [3] Gajje Satheesh
[1] Assistant Professor, Department of Mechanical engineering,
[2,3] U.G. Scholar, Department of Mechanical engineering,
Sri Indu College of Engineering & Technology, Hyderabad.

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Abstract: In recent years, the availability of conventional energy resources has been steadily declining, while the global demand for energy continues to rise due to rapid industrialization and population growth. Among all renewable energy resources, solar energy is one of the most abundant and sustainable sources available. As a result, solar-powered systems have gained significant importance in meeting future energy requirements. In rural and remote regions, conventional water pumping systems that rely on electricity or fossil fuels often face challenges such as high operating costs, irregular power supply, fuel shortages, and environmental pollution. To overcome these limitations, this project proposes a solar-powered water pumping system that utilizes a DC motor to draw water from natural sources such as wells, lakes, rivers, or storage tanks. The system converts sunlight into electrical energy through solar panels, providing a clean and reliable method for water transportation. The proposed model is economical, simple to operate, and suitable for areas where grid electricity is unavailable or unreliable. Since solar energy is freely available, renewable, and environmentally friendly, the system helps reduce operating expenses, minimizes carbon emissions, and supports sustainable agricultural and domestic water supply applications. This solution offers an efficient and eco-friendly alternative to conventional water pumping technologies.

Keywords- Photovoltaic, PMDC motor-pump set, Protection circuit

I. INTRODUCTION

Photovoltaic (PV) panels are often used for residential and agriculture applications, especially in remote areas or where the use of an alternative energy source is desired. In particular they have been demonstrative time and time again to reliably produce sufficient electricity directly from solar radiation (sunlight) to power livestock and irrigation watering system.

A benefit of using solar energy to power agriculture water pump is that increased water requirements for livestock and irrigation tend to co-inside with the seasonal increase of incoming solar energy. When properly designed, these PV system can also resulting in significant long- term cost savings and a smaller environmental footprint compared to conventional power system.

The volume of water pumped by a solar power system in a given interval depend on the total amount of solar energy available in that time period. Specifically, the flow rate of the water pumped is determined by both the intensity solar energy available and the size of PV array used to convert that solar energy into direct current electricity.

Water pumping worldwide is generally dependent on conventional electricity or fuel generated electricity. Solar water pumping minimizes the dependence on fuel based electricity. Solar pumping systems are environment friendly and requires low maintenance with no fuel cost. The technology is similar to any other conventional water pumping system except that the power source is solar energy.

II. LITERATURE SURVEY

Photovoltaic (PV) power for residential and agriculture application is cost-competitive in comparison to traditional energy sources for small scale water pumping requirements. With the continuous increase in fossil fuels cost and reduction in peak watt cost solar cells due to mass production, the photovoltaic power is to become further economical in future is presented in [1]

PV powered water pumping system have become attractive for residential and agriculture applications in remote locations with limited access to conventional electricity. A number of studies have been carried out on performance evaluation, optimization, sizing techniques, efficiency improvement and factors affecting systems performance, economic and environmental aspects of PV pumping systems is represented in [2]

Solar water pumping systems is found to be economically viable in comparison to electricity or diesel based systems for water supplies in rural, urban and remote regions. The investment payback for some PV water pumping systems is found to be 4-6 years. The recent Indian incentives for the promotion of solar water pumping in developing countries are also discussed. PV technology is used for generating electricity from solar radiation. Several attempts have been made to evaluate, monitor and improve performance of different components of PV system's PV module (Abdallah, 2004; Vick and Clark, 2004; Huang and Sun, 2007; Hansen et al., 2000; Lorenzo, 1994), a controller (Hohm and Ropp, 2003), a pump (Vick and Clark, 2011), and pump motor (Bhat et al., 1987) is represented in [3]

Energy is required for a wide range of applications. Electrical energy is the most convenient form of energy which can be converted to all other forms of energy. It is one of the most versatile forms of energy. The current trends in energy consumption are neither secure nor sustainable. Solar energy represents a promising alternative that will likely initially supplement fossil fuel

based energy supply, and eventually replaced the fossil fuel source as the availability of the latter declines. Photovoltaic power control is one of the burning research fields these days is represented in [4]

III. PROBLEMS IDENTIFICATION

The solar connected direct pump is used to overcome the various problems identified or found in conventional electricity based and fuel based water pumping system.

3.1 INCREASE IN FUEL COST

This is the most identified problems in fuel based i.e. gas, diesel based pumping systems. Now a days fuel cost is increasing gradually also the storage of this fuel available in nature is also limited form. Hence this fuel based pumping system is not efficient for the farmers in rural areas

3.2 LOAD SHEDDING OF SUPPLY AT RURAL AREAS

This problem is also found in rural areas which is near to the industrial areas. Because in day time the three phase supply is mostly given to industrial load and hence farmers those uses this supply to run their pump is not available. Therefore supply given to this rural areas at night time period hence farmers go in farms at night time to give water to their crops which is dangerous for them at safety point of view.

3.3 NON-AVAILABILITY OF UTILITY SUPPLY

This means that the motor-pump used by farmers in rural areas which run on either single or three phase supply provided by utility, the non-availability of supply arises in this rural areas because of the farms away from the reach of utility supply. Hence in this condition we have to look on solar pumping system.

3.4 HIGH COST AND LOSSES IN SOLAR AC PUMPING SYSTEMS

This problems find out in solar AC pumping system. Because for AC (single/three phase) motor require AC supply and output of PV array is DC hence we have to design the inverter for motor and also this uses battery for back-up purpose. This will increases the cost of pump set. Also there is 5 - 10 % charging and discharging losses in battery as well as 30-35% conversion losses in inversion process.

3.5 MAINTENANCE OF PUMPS

Conventional electric and fuel based pump requires lot of maintenance and repair work throughout the year. Solar pumping system requires less maintenance as compared to conventional pumps.

IV. SYSTEM DESCRIPSTION AND METHODOLOGY

4.1 WORKING PRINCIPLE

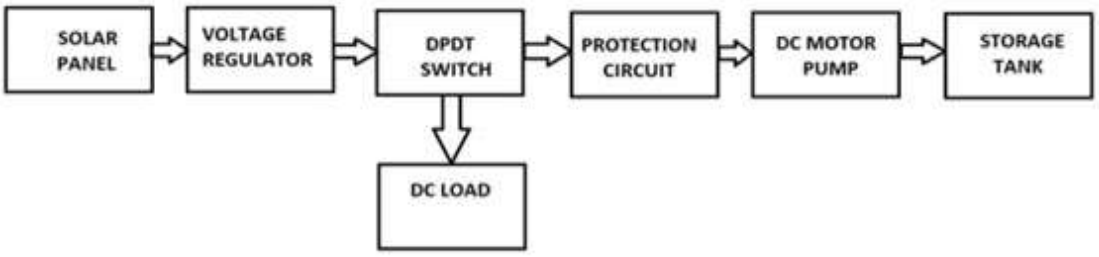

Fig 1. Basic Block Diagram

The block diagram of solar direct pumping system is as shown in fig.1. When sun radiation of sufficient energy is fall on solar panels its start to generate direct voltage. This direct voltage can be given to pump directly but it is not safe to give this direct voltage to pump because sometimes at sunny day the output of panel is increases above rated value which can damage the pump.

Therefore to avoid these overvoltage we have to use voltage regulator to maintain the solar panel output constant level. In these case voltage regulator is nothing but an potentiometer.

The constant output of voltage regulator circuit is next given to a DPDT switch (Double Pole Double Through switch). The output of this switch is next given to both dc load/battery and dc motor pump. Main purpose of using this switch is when we want to run the pump then throw this switch to pump side. Also pump is run about 3-4 hours a day but solar panel generate electricity continuously and we have to use this energy to charge batteries or any other dc loads. Then switch thrown on load side.

The output of DPDT switch is given to protection circuit which is dry run protection to avoid pump to run dry. If pump run dry then its temperature increases and may cause stop to work or damage permanently

Then the output of protection is next given to pump which suck the water from sufficient height. Pump may be surface or submersible pump.

The output of solar panel is also increases by connecting them in parallel as shown in fig. 2.

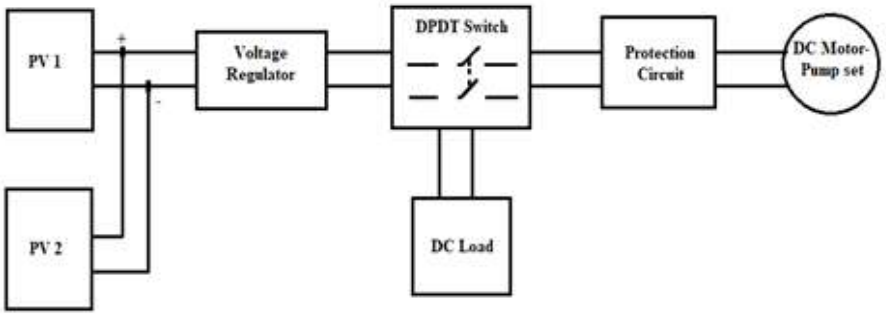

Fig 2. Wiring Diagram of Solar Pump System

4.2 DEMONSTRATION MODEL

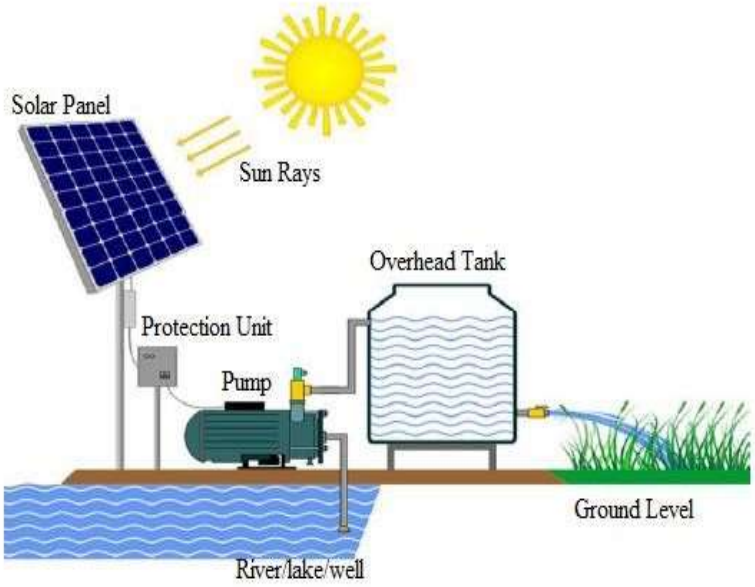

Fig 3. Demonstration of Model

4.3 SOLAR PANEL

Fig 4. Solar Panel Model

Ratings:

Voltage:-12 volt dc

Current: -5.80 Amp

Power: - 100 Watt

Peak Voltage: - 18 V dc

The polycrystalline solar panels is used to generate electricity at 12v dc. There are total two solar panels of 100 watt each is used.

EQUIVALENT CIRCUIT OF SOLAR PANEL

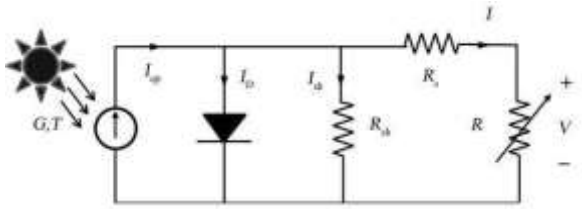

Fig 5. Equivalent circuit of solar panel

CHARACTERISTIC OF SOLAR PANEL

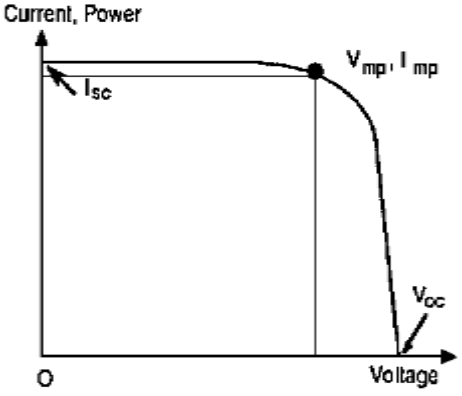

Fig 6. Characteristic of solar panel

CHARACTERISTIC EQUATION

From the equivalent circuit it is evident that current produced by solar cell is equal to that produced current source, minus that which flows through diode, minus that which flow through shunt resistor.

$$I = I_L - I_D - I_{SH} \qquad (1)$$

Current through these element is govern by voltage across them;

$$V_j = V + IR_S \qquad (2)$$

4.4 DC MOTOR-PUMP SET

Fig 7. Dc motor-pump set

Ratings:

Power: - 50 Watt

Speed: - 1500 rpm

Voltage: - 12 volt dc

Current: - 3 Amp dc

A dc motor whose poles are made of permanent magnet DC Motor. The magnets are radially magnetised and are mounted on inner periphery of cylindrical steel stator. Stator of motor serves as return path for flux. Rotor has DC armature, with commutator segments and brushes. The view of PMDC motor is shown in fig.8

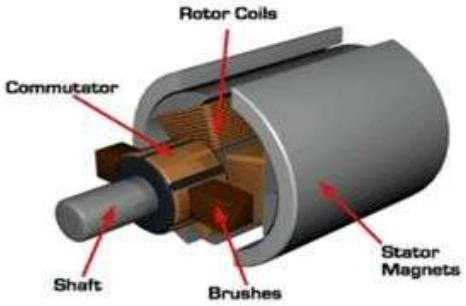

Fig 8. View of PMDC motor

These motor runs on 12 V dc supply obtain from solar panel. The equivalent circuit of PMDC motor as shown in below.

EQUIVALENT CIRCUIT OF PMDC MOTOR

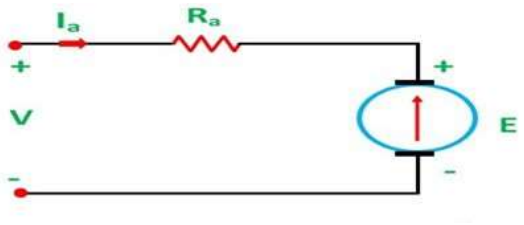

Fig 9. Equivalent circuit of PMDC motor

Generated back emf is given as,

$$E = k \cdot N \cdot \emptyset \qquad (3)$$

Where,

$$k = {}^{PZ}/_{A}$$

Electromagnetic torque is given as,

$$T_e = k \cdot I_a \cdot \emptyset \qquad (4)$$

Now ∅ is constant, hence eq., (1) and (2) is,

$$E = k_1 \cdot N \qquad (5)$$

$$T_e = k_1 \cdot I_a \qquad (6)$$

We know that,

$$V = E + I_a \cdot R_a \qquad (7)$$

Put eq., (3) in eq., (5)

$$V = k_1 N + I_a R_a \qquad (8)$$

This motor is coupled to pump which runs at higher speed and suck the water and produce output at maximum pressure.

4.4.1 WHY DC MOTOR IS USED?

Due to following advantages we use DC motor for the pumping system:

1. DC motor have more starting torque.
2. DC motor pump set have 10% to 15% higher water discharge as compare to Ac motor pump set.

4.5 PROTECTION CIRCUIT

In this project we provides the protection against over-voltage and Dry Run. Also we provides Insect protection.

1. OVER-VOLTAGE PROTECTION*:*

For the protection against over-voltage, the Potentiometer is used. It provides constant 12V dc supply at the output. This will help to operation of DC motor-pump set.

2. DRY RUN PROTECTION

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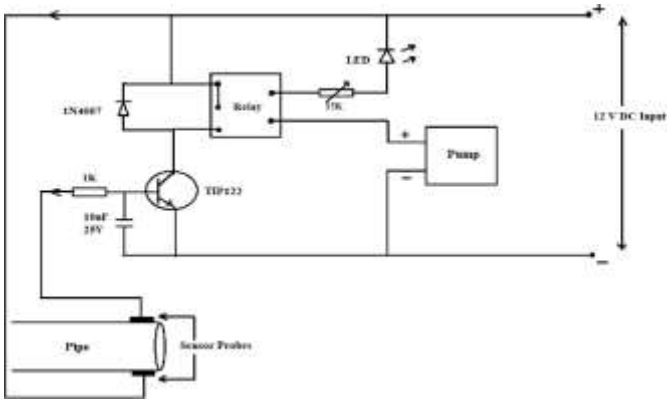

Fig 10. Circuit diagram for Dry Run Protection

In this, water level sensor is fixed on the suction pipe of pump. When the water level is below the sensor then pump will automatically stops. When the water level is reaches above the sensor then pump will automatically starts.

3. INSECT PROTECTION

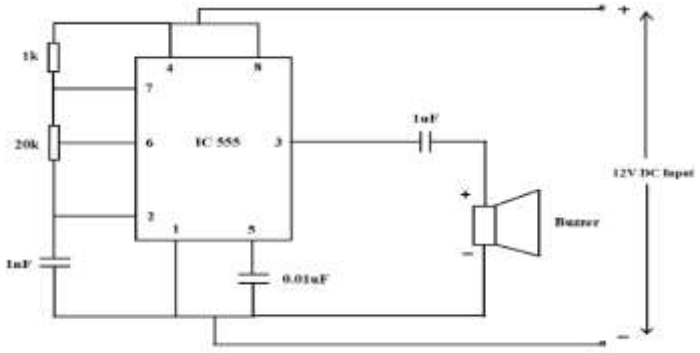

Fig 11. Insect Protection Circuit

IC555 timer is wired here as an astable multivibrator, which will generate square wave continuously upon the power supply of 12 V. Output voltage from pin 3 is given to Buzzer by coupling capacitor 1uF. Frequency determining network is one of important part of this circuit. It consist 1k, 20k and 1nF. They determine frequency of circuit. Each our prey's requires separate frequencies to get repelled. So we have tune this frequency network. By giving supply of 12V DC the buzzer will vibrate at predetermine frequency. This is Ultrasonic Sound at particular frequency. Therefore we can't hear this sound but insects like lizard can hear this sound and they stay away from the panel.

4.6 POTENTIOMETER

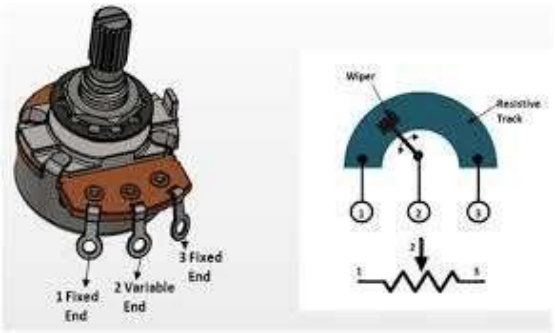

Fig 12. Potentiometer

The potentiometer is used as a voltage regulator. We can vary the solar panel output in different voltage ranges from 0-20V DC. This potentiometer is set to working voltage of 12-15V DC for the pump. Hence it provide constant voltage from 12-15V DC. So, it worked as simple voltage regulator.

4.7 DPDT SWITCH

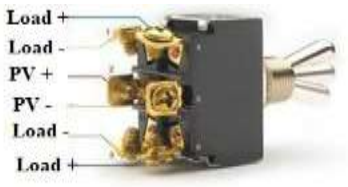

Fig 13. DPDT Switch

Rating of DPDT switch*:* 12V dc, 10A.

- The supply terminals from solar panel is given to the pin no. 2 and 5.
- DC motor –pump is connect to pin no.1 and 4.
- The other dc load or battery is connect to pin No.3 and 6.
- When switch on 2 and 3, 5 and 6 on upper side then supply is given to pump.

When switch on 1 and 2, 4 and 5 on lower side then supply is given to battery.

V. CONCLUSION

Our main aim to conserve the conventional energy sources is successfully done in this project. The main objective of this project is to increase the use of renewable energy source for the water pumping is perfectly implemented. By considering the future energy demand, the renewable energy like solar energy would be a major source of energy. The implementation of our project in rural areas will greatly helpful to their farmers.

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