

IRRIGATION SYSTEM USING PMDC MOTOR POWERED BY SOLAR ENERGY

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ABSTRACT- In this project, a solar energy operated water pump is constructed using PMDC motor for a small-scale irrigation system replacing the conventional system which makes use of natural fuels that are exhaustible and non-friendly to the environment. The main concentration of this project is implementing PMDC motor which is run by the solar power source is because of its abundance and it is more volatile than any other fuel resources. PMDC motors are cheaper and small in size. Permanent magnet DC motor do not require field windings, they do not have field circuit copper losses. The solar powered water pumps can be even implemented in hilly areas where transmission of power from grid is even impossible. The cost involved in solar powered water pumps is very less when compared to conventional systems.

Keywords: Solar energy panels, PMDC motor, Centrifugal pump; Small scale irrigation system.

1. INTRODUCTION:

The purpose of this project is to construct solar energy operated water pump using PMDC motor for small scale irrigation as stated in chapter one. The main contribution of the project is to; reduce the environmental pollution due to the exhausts emissions from conventional water pumps used for small scale irrigation and reducing the foreign currency by reducing the amount of conventional fuel which is imported to operate different mechanical engines including water pumps for irrigation purpose. The conventional water pump has high noise especially if it is diesel engine which affects the wild animals and migrating them from the area. In addition to that the conventional fuel which is used to operate the water pump engine should be transported to the farmer and if leaks on farm land it contaminates the farm affecting the final product. PMDC motor is available in cheaper price and these motors do not require field winding, and do not have field circuit copper losses. This increases their efficiency.

2. LITERATURE SURVEY:

“Designing and Developing Solar Energy Operated Water Pump for Small Scale Irrigation” (Frenjo A, Wogasso A, Ravi R and Muthiya SJ). In this paper, a solar energy operated water pump is designed for a small-scale irrigation system replacing the conventional system which makes use of natural fuels that are exhaustible and non-friendly to the environment. The

main aim of the project is to reduce the man power and increase the production rate.

“Solar Irrigation System using Brush less DC Motor” (Renu Singh, Ahmed Sharique Anees, Devang Tyagi) The paper presents an idea of solar based after pumping system. To fulfill the need of water requirement of an educational institute for different purposes such as drinking, irrigation and other daily requirement the idea is to replace the grid power supply by the solar array system resulting in a huge power saving. The attempts are made to recover the minimum cost of the whole system in minimum years and after that a calculation of revenue is discussed in the work.

“Design and implementation of drip irrigation system with solar energy” (Mahir Dursen, Semih ozden) In this study, an irrigation system with two pieces Brushless DC Motors (BLDC) supplying with solar energy has been designed and applied. One of them to drive deep well pump and the other one to drive centrifugal pump were utilized for the system. Optimum power of motors and solar panels were selected according to calculated maximum power consumption.

“Solar powered Pmdc motor drive” (Mohan Kashyap, Surabh chanan, Jai singh arya) In order to make solar energy competitive with the other forms of renewable energies, a better exploitation of its advantages especially environmental side, this will be possible only with the development of the less expensive and high output efficiency systems. In this paper, the modelling and simulation has been done in Simulink software available with MATLAB for a solar photovoltaic (PV) powered industrial type permanent magnet DC (PMDC) motor drive.

“Development of Solar Powered Irrigation System” (AI Abdelkerim, MMR Sami Eusuf1, MJE Salami, A. Aibinu and MA Eusuf) Development of a solar powered irrigation system has been discussed in this paper. This system would be SCADA-based and quite useful in areas where there is plenty of sunshine but insufficient water to carry out farming activities, such as rubber plantation, strawberry plantation, or any plantation, that requires frequent watering. The system is powered by solar system as a renewable energy which uses solar panel module to convert Sunlight into electricity.

3. SOLAR PANEL, BATTERY AND PMDC MOTOR

3.1. SOLAR PANNEL

The battery is charged with solar energy with the help of a solar cell. Solar cells convert the energy of sunlight directly into electricity through the use of the photovoltaic effect. The photovoltaic effect involves the creation of a voltage into an electro-magnetic radiation. The photoelectric and photovoltaic effects are related to sunlight, but are different in that electrons are ejected from a material's surface upon exposure to radiation of sufficient energy in photoelectric, and generated electrons are transferred to different bands of valence to conduction within the material, resulting in the build-up of voltage between two electrodes in photovoltaic.

Solar cells are electrically connected and fabricated as a module with a sheet of glass on top to allow light to pass and protect the semiconductor from the weather. To obtain a desired peak DC voltage we will add solar cells in series, and to obtain a desired peak current, the solar cells are put in parallel position. Electric ratings of solar panel Parameter Rating.

3.2. BATTERY



Fig-1: BATTERY

A rechargeable battery, storage battery, or secondary cell, (or archaically accumulator) is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use. It is composed of one or more electrochemical cells. The term "accumulator" is used as it accumulates and stores energy through a reversible electrochemical reaction. Rechargeable batteries are produced in many different shapes and sizes, ranging from button cells to megawatt systems connected to stabilize an electrical distribution network. Several different combinations of electrode materials and electrolytes are used, including lead-acid, zinc-air, nickel-cadmium (NiCd), nickel-metal hydride (NiMH), lithium-ion (Li-ion), Lithium Iron Phosphate (LiFePO4), and lithium-ion polymer (Li-ion polymer).

Rechargeable batteries typically initially cost more than disposable batteries, but have a much lower total cost of ownership and environmental impact, as they can be recharged inexpensively many times before they need replacing. Some rechargeable battery types are available in the same sizes and voltages as disposable types, and can be used interchangeably with them.

Billions of dollars in research are being invested around the world for improving batteries.

3.3. DC MOTOR

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many application.

3.4. PERMANENT MAGNET DC MOTOR

The permanent magnet dc motor can be defined as a motor which includes a permanent magnet pole is called Permanent Magnet DC Motor. In this motor, the magnet can be used to make the flux working within the air gap in its place of the field winding. The rotor structure is similar to the straight DC Motor. PMDC Motor's rotor includes armature core, commutator, & armature winding. Normally, in a conventional DC motor, there are two kinds of winding such as armature as well as Filed.



Fig-2: DC MOTOR

The main function of field winding is to produce the functioning magnetic flux within the air gap as well as wound on **the stator** of the motor while armature winding can be wound on the rotor. Inactive carbon brushes are pushed on the commutator like in conventional DC motor. The operating voltage of the PMDC motor is 6 volts, 12 volts otherwise 24 volts DC supply attained from the voltage sources.

4. CONSTRUCTION OF PMDC MOTOR

The PMDC motor's permanent magnets are maintained with a cylindrical-steel stator and these supplies like a return lane for the magnetic flux. The rotor supplies like an armature, and it includes commutator segments, winding slots, & brushes like in conventional dc machines. The permanent magnets used in this motor are classified into three namely Alnico magnets, Ceramic (ferrite) magnets, and Rare-earth magnets.

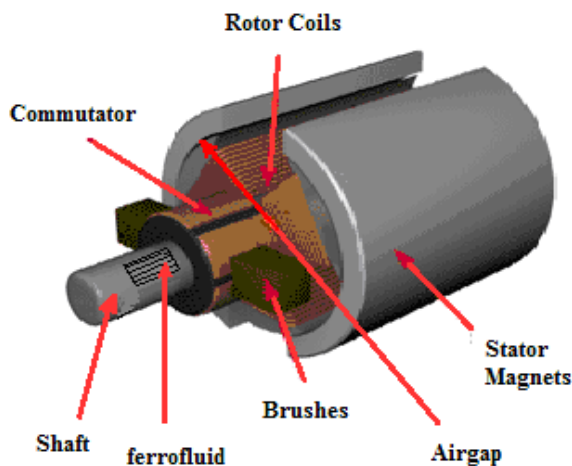


Fig-3: PMDC MOTOR

4.1. OPERATION OF PMDC MOTOR

In this motor, a permanent magnetic field can be generated with the permanent magnets which communicate by the perpendicular field stimulated by the flow of currents within the rotor windings; therefore a mechanical torque can be created.

When the rotor rotates in response to the created torque, then the position among the stator as well as rotor fields can be reduced, and the torque would be reversed in a 90-degree rotation. To maintain the torque performing on the rotor, PMDC motors include a commutator, set to the rotor shaft.

The commutator activates the current supply toward the stator thus as to continue a steady angle = 90, among two fields. As the flow of current is frequently activated among windings like the rotor twists, then the current within every stator winding is truly exchanging at a

frequency comparative to the no.of motor magnetic poles as well as the speed.

4.2. CIRCUIT DIAGRAM OF PMDC MOTOR

The circuit diagram of the PMDC motor is shown below. As in permanent magnet DC motor the field can be generated with the permanent magnet, then there is no requirement of drawing field coils within the PMDC motor equivalent circuit.

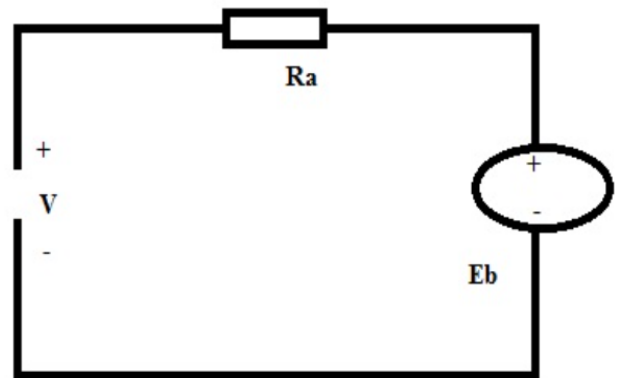


Fig-4: Circuit Diagram

The voltage supply toward the armature will contain fall of armature resistance as well as back of the voltage supply can be countered with the motor's back e.m.f. Therefore the voltage equation of the motor is given by,

$$V = IR + E_b$$

In the above equation,

I= armature current

R= armature resistance

E_b = back emf

V = supply voltage.

4.3. CHARACTERISTICS OF PMDC MOTOR

The characteristics of PMDC Motor include the following.

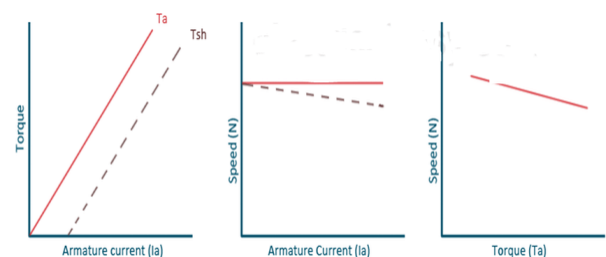


Fig-5: PMDC Motor Characteristics

The PMDC Motor characteristics are related to the dc shunt motor characteristic in terms of speed, torque, as

well as armature current. But, the characteristics of speed-torque are more linear as well as conventional in these types of motors.

4.4. ADVANTAGES AND DISADVANTAGES OF THE PMDC MOTOR

The advantages and disadvantages of the PMDC motor include the following.

- The size of these motors is smaller
- These motors are cheaper
- These motors do not need field windings, and they don't have the copper losses in the field circuit.
- The major drawback of this motor is, the generating capacity of working flux within the air gap is limited. But, due to the expansion of some latest magnetic material such as Samarium Cobalt & Neodymium Iron Boron, this trouble has been determined to some level.

4.5. APPLICATIONS OF THE PMDC MOTOR

The applications of the PMDC Motor include the following.

- These motors are in several applications varying from fractions to numerous horsepower. These are designed with 200 kW to use in various industries.
- These are applicable in automobiles for operating windshield wipers as well as washers, to move up the lower windows, to drive blowers for air conditioners as well as heaters.
- These are used in computer drives, toy industries.
- These motors are applicable in food mixers, electric toothbrushes, and moveable vacuum cleaners.

5. CONSTRUCTION OF SOLAR POWER WATER PUMP

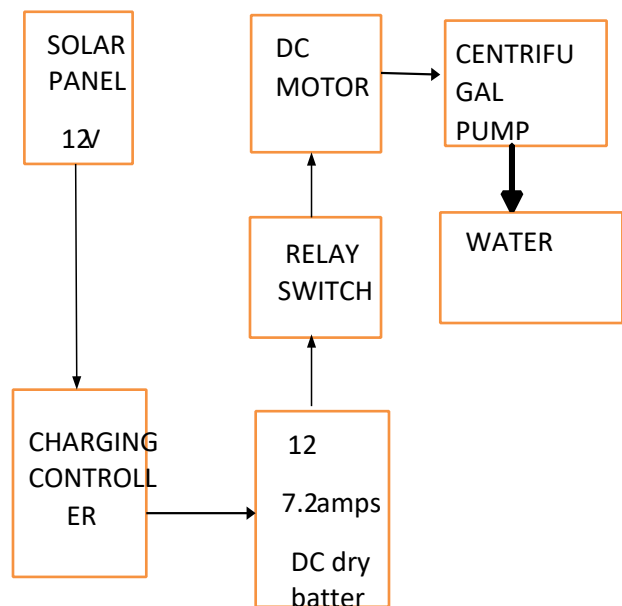


Fig-6: SYSTEM BLOCK DIAGRAM

5.1. WORKING

Solar Energy in the form of light rays falls on the solar photovoltaic panels and got converted into electrical energy through silicon wafers embedded in the solar photovoltaic panels. This electrical energy then goes to the DC based motor pumping system through the cables and operates this motor. By rotation of the shaft coupled to mono-block pump, the pump starts lifting the ground water and throw it out for use.

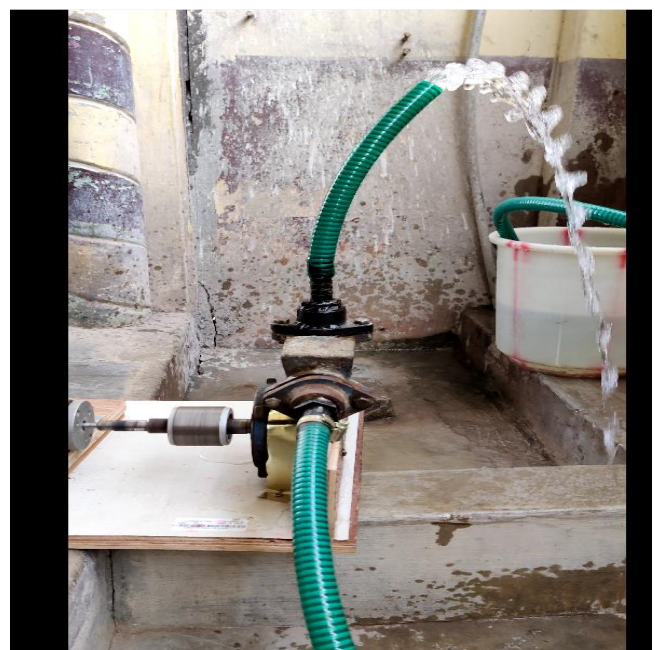


Fig-7: pump setup

The system operates on power generated using solar PV (photovoltaic) system. The photovoltaic array converts the solar energy into electricity, which is used for running the motor pump set. The pumping system draws water from the open well, bore well, stream, pond, canal etc. The system requires a shadow-free area for installation of the Solar panel.

5.2. MECHANICAL STRUCTURE



Fig-8: Structure

The module constructed here is the switch operated one. Through this switch the motor is rotated and pump perform the suction and delivery is done. This unit consists of solar panel, DC motor, centrifugal pump, switch board and a battery for providing power supply to all these devices.

5.3. PUMP MECHANISM

The pumping elements which are known as impellers are components which are used to suck and pressurize the water to move to the expected place in this project reservoir. The type of impeller which is used for this project is centrifugal pumping impeller which is fixed on the brushless dc motor by using some modifications on the electrical motor.



Fig-9: Motor and pump setup

We have fixed this motor and pump with the help of clamps and screws on a wooden block to neglect the vibration and we can get an accurate torque of speed. We have created internal threads in the shaft of the pump and attached it to the motor shaft.

6. Conclusion:

From the experimental results, the following conclusion has been drawn. The 12 V, 1.11-amp PV panel could give 12 V at 30° south to east. It was found that the controller allows the flow of current only if the battery status is low. The 3.33 LPS flow rate of water pump has met the maximum pumping only when the battery is fully charged. As the panel position changed, the voltage production at the PV panel was found to be changed. According to the experiment, as the height increases, the flow rate decreases. It is proved that a solar water pump is suitable for small-scale irrigation.

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