FABRICATION OF SOLAR WATER PUMP FOR GARDENING

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ABSTRACT

The performance of a solar water pumping system is discussed in this project. The system consists of a photovoltaic (PV) array, a permanent magnet (PM) DC motor and a helical rotor pump. Photovoltaic cells frequently referred to as solar cells, convert the light part of the solar spectrum (Sunlight) into electricity. They are the most rapidly expanding energy sources in the world. Large scale manufacture of photovoltaic cells, coupled with continued research and development is expected to further make photovoltaic with in the economic framework of rural areas in developing countries. 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 nonfriendly to the environment

1.INTRODUCTION

Solar energy is the fastest growing and most affordable source of new electricity in America. Over 3 million installations have been built across the country—with 1 million being built in the last two years. As the cost of solar energy systems dropped significantly, more Americans and businesses have taken advantage of clean energy.

A solar water pump is an innovative technology water lifting system that is powered by solar energy. It is also known as Solar Pumping System, Solar Submersible Pump, and Solar Pump. This system typically consists of a solar panel, solar inverter, controller, and sometimes a solar battery. These pumps are more economical since they don't need grid electricity and reduce carbon footprints too.

This guideline provides the minimum knowledge required when designing, selecting and installing a solar water pumping system.

When designing a solar pumping system, the designer must match the individual components together. A solar water pumping system consists of three major components: the solar array, pump controller and electric water pump (motor and pump) as shown in Figure

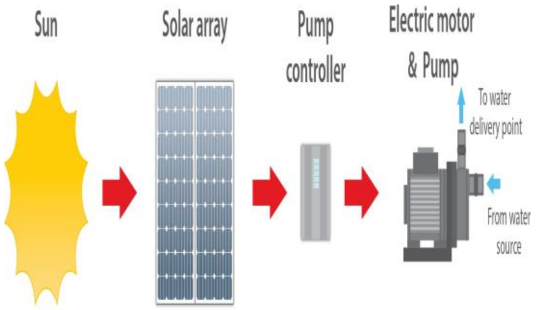

Figure 1: Solar water pump system

Unlike other design guidelines, this guideline does not cover how these three components are sized and matched, this has already been undertaken by the solar water pump manufacturers/suppliers. Design and selection of the correct solar water pumping system mainly requires knowledge of the actual site including:

- Solar Irradiation;
- How much water is required to be pumped each day; and
- The total dynamic head.

A solar water pump manufacture/supplier will have tables or computer software which specify the flow from the solar water pumping system for various heads and solar irradiation. The "solar water pump designer" shall be capable of:

- Determining the solar irradiation for the site:
- Determining the volume of water required on a specified time basis, typically daily;
- Measuring the static head;
- Measuring the length of pipe required;
- Selecting the appropriate type of pipe and its diameter;
- Calculating the total frictional losses (friction head) for the type, size and length of pipe used;
- Calculate the total dynamic head for the site; and
- Using the manufacturers data sheets or software to select the most appropriate solar water pumping system.

1.1. System Types and Configurations:

There are many possible applications for solar water pumping, especially when considering that the pump can be combined with energy storage or other types of generation to make it more versatile. However, this guideline is related to solar only systems. These would typically be used for supplying water for a village, an individual residence or a resort. Other potential applications could be for agricultural irrigation or water for animals. In general battery storage is not used, storage in the form of water tanks, often elevated to provide pressure for delivery, takes the place of batteries in most of these systems.

A solar water pump theoretically consists of three key components: a pump control system that may be just an on-off switch or may be a more complex electronic unit, a motor and the pump; however, in practice they are considered as one unit and generally called the "water pump" or in this guideline the "solar water pump".
The different system configuration can be defined by:

- How the electric pump is powered (dc or ac);
- The mounting of the water pump (submerged, floating or on the surface);
- The type of the water pump (roto-dynamic or positive displacement)

1.2. How the electric pump is powered?

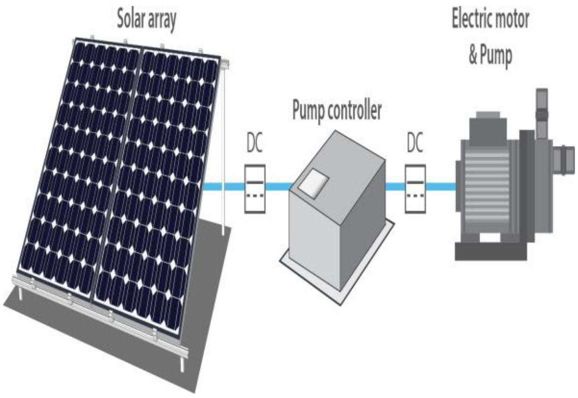

Figure 2: solar array

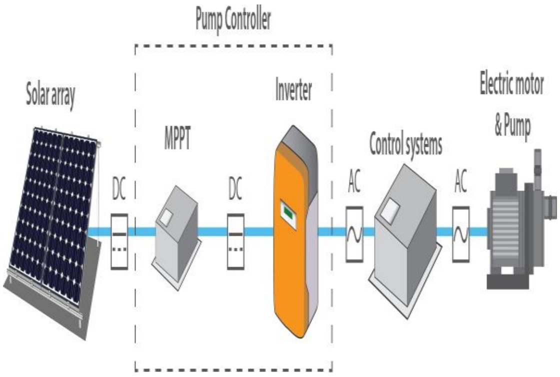

Figure 3: solar water pump system

The "pump controller" in the dc powered pump system would typically include a maximum power point tracker (MPPT) to ensure that the solar array is delivering power at its peak power point.
The "pump controller" in the ac powered pump system would include an MPPT as well as a dc to ac inverter in order to operate the ac electric motor which is part of the water pump. In larger systems these should be three-phase inverters to operate three-phase motors.

1.3 Solar Water Pump Technologies: There are three technologies to power your solar surface water pump (AC & DC) and solar submersible water pump (AC & DC). A brief description of these technologies is mentioned below.

1.4 On-Grid Solar Pump: In an on-grid solar system, your water pump will be powered by a solar panel. In case the solar panel is generating more power than the water pump's consumption, then the excess power will automatically be exported to the grid via net metering and the government will adjust it in your next electricity bill.

1.5 **Hybrid Solar Pump:** In a hybrid solar pump, there are three power options to run the solar pump. First is solar power, second is the grid electricity and the third is a solar battery. In day time your water pump is powered by solar electricity, at night it is powered by the grid and when both (solar power and grid) are not available then it will be powered by a battery.**Solar Pump VFD Drive:** VFD drives are a modern solution to the problems of farmers. Solar pump VFD drive converts your existing water pump into a solar pump. This technology is becoming famous day by day. There is a shortage of electricity in the rural area and through VFD drive farmers can operate their pumps even when there is no grid. Using solar panels sunlight can be converted into electricity which can run pumps to transport water either from underground (submersible pumps) or on the surface (surface pumps). These solar pumps are driven by a permanent DC motor connected directly to an array of solar panels. Surface pumps are suitable for areas were the water level is within 5 m below pump level commonly from shallow surface water sources such as bore wells, open wells, reservoirs and lakes. These pumps have a total dynamic head of 14 m. The maximum suction head is typically 5m. Submersible pumps are completely immersed in water and function on the principle of water displacement. These pumps are suited both to deep well and to surface water sources. The initial and installation costs of these pumps are high but they have a longer life and greater reliability than surface pumps (Scherer 1993).

2. LITERATURE REVIEW

The research goal was to develop a new solar water heater system (SWHS) that used a solar water pump instead of an electric pump. The pump was powered by the steam produced from a flat plate collector. Therefore, heat could be transferred downward from the collector to a hot water storage tank. The designed system consisted of four panels of flat plate solar collectors, an overhead tank installed at an upper level and a large water storage tank with a heat exchanger at a lower level. Discharge heads of 1, 1.5 and 2 m were tested. The pump could operate at the collector temperature of about 70–90 °C and vapor gage pressure of 7–14 kPa. It was found that water circulation within the SWHS ranged between 12 and 59 l/d depending on the incident solar intensity and system discharge head. The average daily pump efficiency was about 0.0014–0.0019%. Moreover, the SWHS could have a daily thermal efficiency of about 7–13%, whereas a conventional system had 30–60% efficiency. The present system was economically comparable to a conventional one.

Two types of solar water pumps for lift irrigation have been developed and tested. In this paper the thermodynamic and design aspects of the pumps are discussed. The pumps have no moving parts except for the check valves. No auxilliary power source or technical skill is required to run the pumps making both designs extremely suitable for rural lift irrigation. The running cost is nil except for the occasional use of an inexpensive organic fluid. Feasibility studies of the pumps indicate that they are economically viable and are within the means of an Indian farmer.

A brief description of the operation and analysis of a solar water pump is given. It is shown that one of the parameters affecting the performance of the pump is the time taken for condensation of the working fluid in each cycle. The condensation time in each cycle is determined through heat transfer analysis of the condenser. The effects of inlet water temperature and mass flow rate of the cooling water to the condenser on the condensation time and the pump performance have been studied and discussed.

A solar water pump for lift irrigation, which was shown to be economically viable, was proposed by Rao and Rao [5]. A "modified pump" is suggested, which is suitable for village water supply. The thermodynamic analysis of the pumps is presented. Though the solar water pump is intended to be operated with flat-plate collectors, it is analysed whether the pump could be run more efficiently when coupled with concentrating collectors. The analysis is also applicable for bellow actuated solar water pumps.

METHODOLOGY

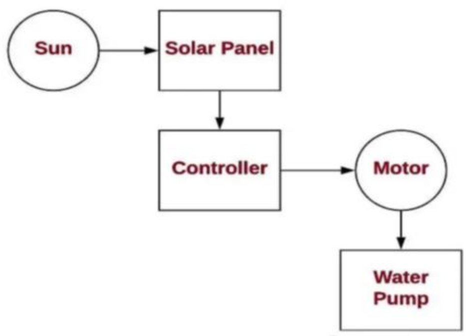

Figure 4: Block Diagram

3. PROJECT WORK PLAN:

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.

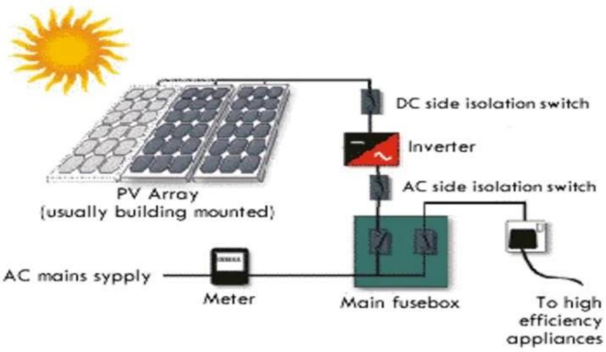

Figure 5: Solar Water Pump System

- **Submersible Pump:** The submersible pumps pump water from deep depth, e.g., underground water sources such as shallow wells and boreholes.
- **Circulator Pump:** These pumps circulate the water to keep it warm and prepared for utilization and ensure a continuous water supply.
- **Booster Pump:** The booster pump provides the pressure needed to pump water from a storage tank and deliver it to the entire home or facility.

The use of solar power to pump water has a lot of advantages and is useful in many situations such as: for reasons of cost efficiency in the case of the resources for the water located over a wide distanced area; higher costs of other regular alternative methods such as the use of fuel; the lack and expense of power line infrastructure over long distance. The fact that DC power is used in solar water pumps as opposed to AC powered devices gives the advantage of the solar pumps being able to function under circumstances of imperfect sunlight conditions. AC power on the other hand needs relatively unchanging voltage as well as frequency to run smoothly. This DC use in solar water pumps allows the device to operate on varying voltage and current. Furthermore pumps that use AC power need sufficient power to transport large amount of water in a short time. Solar pumps however

4. DESIGN AND FABRICATION

MAIN COMPINENTS REQUIRED FOR SOLAR WATER PUMP:

- Water Pump
- Solar Panels
- Battery
- Solar Charge Controller

SOLAR PUMP

Solar water pump is driven by the electricity produced by the PV (photovoltaic) panels or the radiant heat generated by collected sunlight. This is the opposite of a diesel or grid electricity water pump.

A water pump is an important part of a water pumping system. These pumps have various types such as sump pump, booster pump, circulating pump, and submersible pump.

does it differently where the solar pumps transport smaller amounts of water for a longer period and would obviously require less energy than AC powered means.

Solar Panels:

Solar panels are a key part of the solar-powered water pump. A group of solar panels is called an array. Solar panels generate electrical energy by separating electrons from atoms by permitting photons and light arrays, which creates electricity.

Solar panels are made up of small units called solar cells that change sunlight into electrical energy. There are several types of solar energy technologies like concentrated solar energy and solar thermal. These work differently than PV solar panels. However, these also use the energy of sunlight to generate electricity to drive water pumps.

Silicon is a semiconductor and the fourteenth component in the periodic table. It has 4 valence (electrons at the outer shell). Silicon particles offer valence electrons to achieve stability. To aggravate this stability, doping atoms are embedded into the silicon. Silicon 11 can be combined with Bromine (positively doped) and can be combined with Phosphorus (negatively doped). Furthermore the 20% are made up of solar cells which are made mostly from Cadmium Telluride and a small portion of CIGS or Copper Indium Gallium Selenite. These cells have an advantage of being low cost and therefore can be made into large single sheets.

The amount of Electricity used is dependent on a number of factors such as the solar panel itself and the cell technology underlying it as well as the material used in making it; the sunlight exposure at the specified location per year.

Solar Batteries

The battery of the solar powered water pump system stores the charge produced by the solar panel; in the presence of sunlight, the energy produced by the solar panel supplies to a load and a battery.

If the load requirement is greater compared to the energy obtained by the solar panels, these batteries deliver a stable source of energy to the pumping system. The battery ensures that the water pumping system is working in the sunlight or not.

Deep cycle batteries often use for solar energy purposes because they are repetitively and deeply discharged.

Figure 6: Solar batteries

Solar charge Controllers

The pump controller can adjust the pump system parameters to meet user needs and shield the pump system. These can use for the water to set an extraction schedule. The scheduled water helps to maximize the pump life.

Figure 7: solar charge controller

The pumps are the system component most understood by the farmers, because in almost all cases, they have already been using pumps of some kind. In several cases, we saw farmers use their existing electric pumps with the new panels and the majority of salt farmers interviewed pump using the solar panels during the day and using diesel generators at night.

5. CALCULATIONS:

- **Solar panel:**

  Voltage = 50 Watts (12Volts), Material = Poly crystalline, High

  efficiency

- **Pump:** Maximum flow rate = 600 lit/hr = 10 lit/min
- **Motor:** Voltage = DC 12V, Power = 8 watts, Flow rate = 10 lit/min
- **Battery:** Voltage = 12 Volts, Ampere-h = 7Ah

According to the above given data

Battery capacity = 7Ah, Battery Voltage = 10V;

- hours does the battery charges by using 50W Solar panel

Therefore power of solar panel (P) = 50 W

Therefore power (P) = voltage (V) * current (I)

- To find current:

50 = 12*I

I = 50/12

Current (I) = 4.16 Amps

- So, the charging time would be,

7Ah/4.16A = 1.6 = 2 hours

- This is an Theoretical assumption. It takes more than 2 hours time to charge the battery as while charging always there is power loss.

- Llitres of water is discharged by using 12v DC Motor and 12V battery

Battery capacity in Hours = 10 hours, Flow rate = 10 lit/min = 0.16 lit/hrs

Therefore 10hrs*60 = 600min

- Maximum Flow rate to discharge water for 10hours of battery capacity = 600 min*10 lit/min = 6000 litres

Solar Pump Applications

The major applications of the solar pumps are given below:

These pumps use to supply water for animals. They use for irrigation systems.

They also use to supply water for drinking and cooking purposes. These pumps may also utilize as booster pumps for pumping fluids over long distance. Solar pumps use for water treatment applications. These also use for the extraction of oil and gas

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Final Fig Project Picture

CONCLUSION

The output of solar water pumping system depends on accurate size & demand data. Solar power pump can play a significant role in the inadequate supply of electrical energy. Also Photovolatic pumping systemic very good alternate of electricity system. In the 21St century big challenges is the Global Warming for humanity therefore using this renewable energy sources to overcome this problems.

FUTURE SCOPE

Over the past decade, the cost of solar has fallen dramatically. New technologies promise to increase efficiency and lower costs further. Solar energy will soon be unbeatable compared to fossil fuels. In the coming years, technology improvements will ensure that solar becomes even cheaper. It could well be that by 2030, solar will have become the most important source of energy for electricity production in a large part of the world. This will also have a positive impact on the environment and climate change. Collecting groundwater for potable use is a basic global human need, and Franklin Electric is a pioneer in the field. Solar panels have been around for many years, and recently, costs have declined such that the solar photovoltaic (PV) industry is challenging the business model of the standard energy company. Many countries are at, or have surpassed, "grid-parity" with solar PV versus conventional energy sources.

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