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Solar Powered Pumping System by Using Microcontroller

#1Harsha G. Nathjogi

[1]harshanathjogi295@gmail.com

#1Lecturer, GF'S Godavari College of Engineering, Jalgaon, India

ABSTRACT

Renewable energy sources in general and solar energy source in particular, has the potential to provide energy services with almost zero emission. The solar energy is abundant and no other source in renewable energy is like solar energy. The purpose of this to design and implement of "SOLAR POWERED PUMPING SYSTEM BY USING MICROCONTROLLER" It is based on photo-voltaic or solar modules, which are very reliable and do not require any fuel or servicing. Solar electric systems are suitable for plenty of application and are ideal when there is no main electricity. Because photo-voltaic systems burn no fuel and have no moving parts, they are clean and silent, producing no atmospheric emissions or greenhouse gases to cause detrimental effects on our water, air and soil. Microcontroller it is controls the various operations taking place during processing. The solar radiation is used to fulfill the power requirement. The power from solar panel is then transform to switching circuit which switch the capacitor banks to the load which is mechanical water pump. Capacitor as a source of storage of charge rather than the battery. It is used in small scale industrial application which required constant DC supply and control system where battery to be used for very high cost and size. Free water pumping at no electrical consumption and no problems of load shading, saving of money is possible by implementation of the system. For solar tracking controller, we need to measure different parameters as surrounding temperature. The solar panel targets the radiation from the sun. Other than that, the solar system has reduce energy cost as well as pollution. Solar water pumping with maximum power tracking. We will have a system which we will continuously run the capacitor bank and charge is discharge to the pump continuously. As the charge is stored shortly the wattage requirement reduces considerably and yielding a better result.

Keywords: Microcontroller, capacitor Bank, Solar energy, Solar panel.

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I. INTRODUCTION

The increasing demand for energy, the continuous reduction in existing sources of fossil fuels and the growing concern regarding environment pollution, have pushed mankind to explore new technologies for the production of electrical energy using clean, renewable sources, such as solar energy, wind energy, etc. Among the non-conventional, renewable energy sources, solar energy affords great potential for conversion into electric power, able to ensure an important part of the electrical energy needs of the planet. The conversion of solar light into electrical energy represents one of the most promising and challenging energetic technologies, in continuous development, being clean, silent and reliable, with very low maintenance costs and minimal ecological impact. Solar energy is free, practically inexhaustible, and involves no polluting residues or greenhouse gases emissions. The conversion principle of solar light into electricity, called Photo-Voltaic or PV conversion, is not very new, but the efficiency improvement of the PV conversion equipment is still one of top priorities for many academic and/or industrial research groups all over the world.

1.1 Principal Of Operation Of Solar Energy

Solar energy is available in abundance in most parts of the world. The amount of solar energy incident on the earth's surface is approximately 1.5 x 10^{18} kWh/year, which is about 10,000 times the current annual energy consumption of the entire world. The density of power radiated from the sun (referred to as solar energy constant) is 1.373 kW/m^2. Fuel deposit in the earth will soon deplete by the end of 2020. Fuel scarcity will be maximum; country like India may not have the chance to use petroleum products. Keeping this dangerous situation in mind we tried to make use of non-pollutant natural resource of solar energy.

The creation of new source of perennial environmentally acceptable, low cost electrical energy as a replacement for energy from rapidly depleting resources of fossil fuels is the fundamental need for the survival of mankind. We have only about 25 years of oil reserves and 75 – 100 years of coal reserves.

Solar power stations provide a cost-effective solution even though work on solar photo voltaic and solar thermo electric energy sources has been extensively pursued by many countries. Earth based solar stations suffer certain basic limitations. It is not possible to consider such systems and meeting continuous uninterrupted concentrated base load electric power requirements.

II. LITERATURE REVIEW

Solar radiation is format among the promising new source of energy. India receives annually over 60 x 1000 MWH of solar radiation with a span of 3000 – 3200 hrs in Rajasthan, Gujarat, West of Madhya Pradesh and North of Maharashtra; and 2600 – 2800 hours in the rest of the country excepting Kerala, Assam and Kashmir.

Energy from the sun can be utilized in multifarious ways. It can be tapped directly from solar radiation in the form of thermal, thermodynamic and photovoltaic energy and indirectly through the production of photo mass and other related energy sources such as wind, hydropower and ocean energy all of which are the result of solar radiation on the planet Earth. The contribution of these sources in the total consumption of energy in the world is about 15%.

Traditionally, the utilization of solar energy has been confined to drying of agricultural products such as grain, maize, paddy, grinder, cashew, pepper, tobacco curing, fish and food drying. Its commercial application has been limited to production of common salt and other marine chemicals like potash, cromide and magnesium salts.

In recent years, the fastest growing energy technology has been the grid-connected PV market segment in industrial countries, growing over 60% per year from 2000 - 2004. It covers more than 400,000 rooftops in Japan, Germany, and the United States. Of the 410 MW installed across Europe in 2004, 403 MW was grid connected and 8 MW was off-grid.

Keshner and Arya designed a “Solar City” factory that would process 30 million sq. meters of glass panels per year and produce 2.1 – 3.6 GW (peak output, terrestrial) of solar panels per year — 100x the volume of a typical, thin-film, solar panel manufacturer in 2004. With a reasonable selection of materials, and conservative assumptions, this “Solar City” can produce solar panels and hit the price target of $1.00 per peak watt (6.5x - 8.5x lower than prices in 2004) as the total price for a complete and installed rooftop (or ground mounted) solar energy system.

Their breakthrough in solar energy price comes without the need for any significant new invention. It comes entirely from the manufacturing scale of a large plant and the cost savings inherent in operating at such a large manufacturing scale. At $1.00 per peak watt for a complete and installed system, the payback time in states like California is under 5 years. Therefore, Keshner and Arya expect the demand for solar energy systems to explode.

The photoelectric effect was first noted by a French physicist, Edmund Becquerel, in 1839, who found that certain materials would produce small amounts of electric current when exposed to light. In 1905, Albert Einstein described the nature of light and the photoelectric effect on which photovoltaic technology is based, for which he later won a Nobel Prize in physics. The first photovoltaic module was built by Bell Laboratories in 1954. It was billed as a solar battery and was mostly just a curiosity as it was too expensive to gain widespread use. In the 1960s, the space industry began to make the first serious use of the technology to provide power aboard spacecraft. Through the space programs, the technology advanced, its reliability was established, and the cost began to decline. During the energy crisis in the 1970s, photovoltaic technology gained recognition as a source of power for non-space applications.

Global annual PV production levels exceeded 1 Gig watts for the first time in 2004. In 2005, PV became a $7.5 billion per year industry. Solar buzz expects the industry to top $18.5bn in 2010. While PV production has been growing at about 36% per year for the previous decade, in 2004 it notched a 62% growth.2

Preliminary estimates for 2005 by PV News show global PV cell production increased more than 40% from nearly 1200 MW in 2004 to 1727 MW in 2005. The real surprise is the more than doubling of cell production by small, global producers outside of the major markets to 289 MW, a dynamic likely to continue in 2006.

Worldwide annual PV installation is projected to reach 3.2 Gig watts by 2010, continuing its strong growth in spite of current problems; notably a growing shortage of silicon feedstock. Light weight, efficient, low cost and durable photovoltaic cells are an essential key to building SSP. Can industry make such cells necessary for SSP to succeed?

By using thin film made from CIGS (copper, indium, gallium and selenium); Honda achieves a 50% reduction in energy consumed during manufacturing compared to conventional crystal silicon solar cells. Honda says its next-generation solar cell has achieved the highest level of photoelectric transfer efficiency for a thin film solar cell almost equivalent to the conventional crystal silicon solar cell.

III.PROCESS INVOLVED

3.1 SOLAR PANEL

This block has array of photovoltaic cells arranged in this manner to deliver 12 vdc, where each cell has voltage of 1.5v each, the parallel connection of the cells is done to meet the current capacity.

If 12 v then 9 cells are connected in series, here the power requirement is considered to be a 750mA,then the total power output from the panel will be 12$\times$750mA=9w approx, then the panel to be chosen more than this ratings. So that it can sufficiently deliver the required output. The panel we have chosen is 20 w power output capacities.

3.2 SPECIFICATION OF SOLAR PANEL

1) Maximum power = 20 W
2) Voltage at max. power =17 V
3) Current at max. power =1.18 A
4) Open circuit voltage =21 V
5) Short circuit current =1.21 A

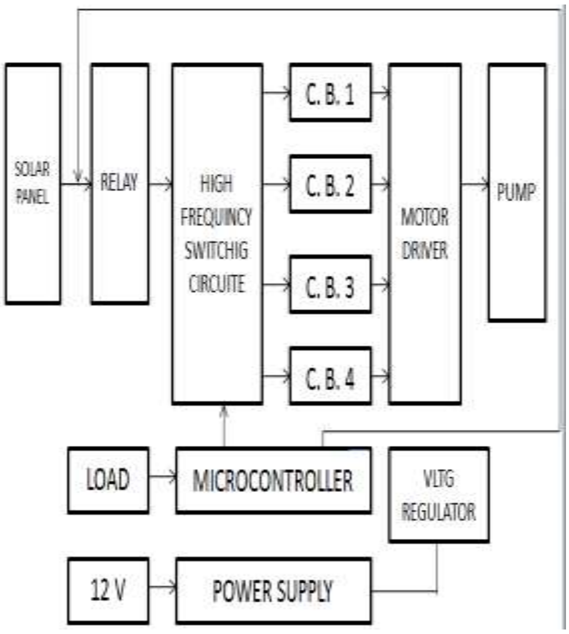

Fig 1:-Block diagram

3.3 SOLAR PANELS

- **MONO-CRYSTALLINE**

This type of solar cell uses a single layer of silicon for the semi-conductor. In order to produce this type of cell, the used silicon must be extremely pure which means it is the most expensive type of solar cell. However, they are the most efficient type of solar panels. Their performance is somewhat better in low light conditions (but not as good as some advertising this type is warranted for 20-25 years. They are usually blue-grey in colour and have a fairly uniform consistency.

Fig 2: Mono crystalline Solar Panel

3.4 SOLAR PANEL – STRUCTURE

A typical solar cell is a multi-layered material. The layers are:

1) Cover Glass - this is a clear glass layer that provides outer protection from the (weather) elements.
2) Transparent Adhesive – to stick the glass to the lower layers of the solar cell.
3) Anti-reflective Coating - this substance prevents light that strikes the cell from bouncing off so that the maximum energy is absorbed into the cell.
4) Front Contact - transmits the electric current.
5) N-Type Semiconductor Layer - This is a thin layer of silicon which has been doped with phosphorous.
6) P-Type Semiconductor Layer - This is a thin layer of silicon which has been doped with boron.
7) Back Contact - transmits the electric current.

3.4 WORKING OF PHOTOVOLTAIC CELL

The diagram below illustrates the operation of a basic photovoltaic cell, also called a solar cell. Solar cells are made of the some kinds of semiconductor materials, such as silicon, used in the microelectronics industry. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material.

If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of an electric current -- that is, electricity. This electricity can then be used to power a load, such as a light or a tool.

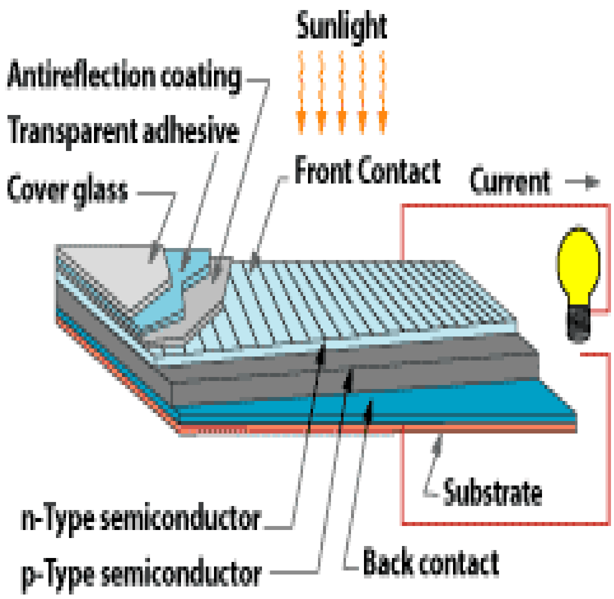

Fig 3:- Working principle of photovoltaic cell

A number of solar cells electrically connected to each other and mounted in a support structure or frame is called a photovoltaic module. Modules are designed to supply electricity at a certain voltage, such as a common 12 volts system. The current produced is directly dependent on how much light strikes the module

3.6 HIGH FREQUENCY SWITCHING CIRCUIT

It is a switching network, which switches in the particular capacitor bank one by one into circuit for charging purpose. This is done at high frequency which is controlled by the micro controller; the switching frequency is so chosen that it is just more than the capacitor discharge cycle. So no discontinuity in the output voltage is observed.

Here two sets of the block is used one switches the capacitor bank in the circuit for charging purpose and the other block switches in the capacitor bank to load. We are using IC ULN2003 for this purpose.

3.7 CAPACITOR BANK

This block contains the three capacitor banks, the capacitor bank consists of the parallel connected capacitor of high value such as 4700 mfd/35v, as it retains the charge for more time and takes long time to discharge which is sufficient for the driving of the small load. Here four such banks are used to form a one cycle and provide continuous dc voltage to the pump.

The voltage level is maintained at fixed value because of the use of the number of banks. The number can be increased if load is increased.

3.8 MICRO CONTROLLER

Micro controller makes the switching of the banks possible, here three output is taken at the port terminal and these terminals are made high at high frequency that time is decided using the timer settings internally that means calculating the time delay, and programmed to sequentially make the pins high in a cyclic manner. Microcontroller switches the banks for charging purpose as well as for discharging purpose. The switching of the banks in to the circuit is totally governed.

Microcontroller Atmel At89c51

Features:

- Compatible with MCS 51 Products
- 4K Bytes of Reprogrammable Flash Memory
- 2.7V to 6V Operating Range
- Fully Static Operation: 0 Hz to 24 MHz
- Two-level Program Memory Lock
- 128 x 8-bit Internal RAM
- 15 Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources
- Programmable Serial UART Channel
- Direct LED Drive Outputs
- On-chip Analog Comparator
- Low-power Idle and Power-down Modes

Fig 4:- Connections of capacitor banks with micro-controller circuit

IV. SOLAR TRACKING SYSTEM DESIGN

It will have a fixed vertical axis and an adjustable horizontal motor controlled axis. This setup is similar to an office swivel chair. The tracker will actively track the sun and change its position accordingly to maximize the energy output. To prevent wasting power by running the motor continuously, the tracker will correct its position after 2 to 3 degrees of misalignment.

The sensors will compare the light intensities of each side and move the panels until the tracker detects equal light on both sides. Additionally, it will prevent rapid changes in direction that might be caused by reflections, such as cars passing by. A rear sensor circuit is also incorporated to aid in repositioning the solar panels for the next sunrise. The gear motor will have overturn triggers to prevent the panel from rotating 360° and entangling wires. The motor control and sensing circuitry will run on batteries charged by the solar panel. This project will use one small 20W solar panels of approximately of 43 cm by 31.2 cm area.

V. GEAR SPECIFICATIONS

For solar tracking system, we are using low speed 12 V dc geared motor. The rpm of 12 V dc geared motor is specified as 15 rpm. We have selected low speed according to tracking system requirement.

The output of geared motor is connected to the plastic spur gear through worm gear. Gear specifications are as follows:

We have assumed the diameter of worm gear as 8 mm and material of worm gear is steel 40C8.

SPUR GEAR SPECIFICATION:

1) No. of teeth = 66
2) Pitch circle diameter = 37 mm
3) Rpm = 2 rpm

WORM GEAR SPECIFICATIONS:

1) No. of teeth = 8
2) Pitch circle diameter = 8 mm
3) Rpm = 15 rpm

VI. SINGLE PISTON DIAPHRAGM PUMP

Diaphragm pumps work using a simple method of operation. Liquid is pumped using two diaphragms fixed to both ends of a centre rod. The rod is actuated by air pressure. Four simple ball valves are used to control the circuit. Compressed air enters air chamber A (shown in fig.), moving the center rod to the right, forcing liquid out of liquid chamber A, while at the same time drawing liquid into liquid chamber B. When the centre rod is fully to the right the pneumatic logic system switches the supply of air from air chamber A to air chamber B. The centre rod then moves to the left, forcing out the liquid from liquid chamber B, while at the same time drawing liquid into liquid chamber A. Through the repetition of this action a constant flow of liquid is achieved.

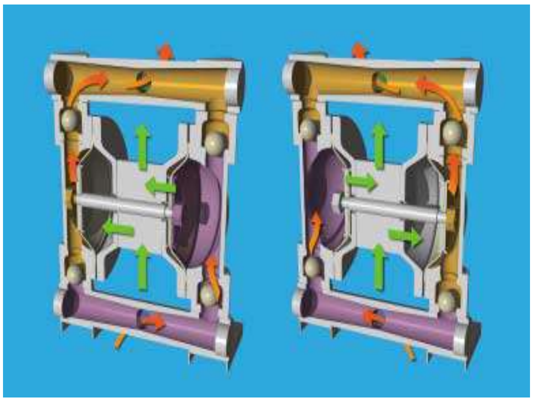

Fig 5:- Diaphragm pump

VII. ADVANTAGES

1. Less weight as compared to battery powered project.
2. No charging of battery so no time lapse.
3. Less loss of energy.
4. Total cost will be lesser than the battery powered.
5. The overall efficiency is more
6. No need of battery, and thus the charging time is eliminated and due to this the cost is also reduced.
7. Due to the absence of battery and its charging and discharging the losses in the system are greatly reduced and the system becomes highly efficient.
8. The life span of the capacitor bank and the solar panel is very long as compared to the battery.
9. The whole system is environment friendly and thus generates green energy.
10.Total cost will be lesser than the battery powered instrument.

IX. DISADVANTAGE

1. As it is solar powered so it is a necessity that presence of sun light is required.
2. Battery can be used for rain days.

X. APPLICATION

1.This system can be used at remotely and complicated Terrance where conventional supply cannot be reached.

2.It can also be used in small scale industrial application which require constant DC supply and control system where battery to be used goes for very high cost and size.

3.In household use where battery can be used so as to reduce cost and space.

4.It can also be implemented in vehicles.

5.Free water pumping at no electrical consumption and no problems of load shading, saving of money.

XI. CONCLUSION

Thus it concludes that the mechatronical system with micro-controller and capacitor bank is preferable for getting the continuous power supply to pumping the water. The system really eliminates the battery storage system and expenses and problems of charging and discharging it.

Based on the obtained results we can conclude that the proposed solution for a solar tracking system offers several advantages concerning the movement command of the PV pane. A maximization of output energy produced by the PV panel, through an optimal positioning executed only for sufficient values of light signal intensity a guarantee of the panel positioning starting from any initial position of the PV panel;

The elimination of unnecessary movements, at too small intensities of the light signals or at too small differences between the signals received from the two LEDs.

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