

Design and Fabrication of Solar Powered Reciprocating Pump

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Abstract— In present days, people need more and more power for driving instrument. A solar based reciprocating pump is a pump, running on electricity generated by solar cell, available from collected sunlight as opposed to greed electricity in run water pump. Nowadays many types of pump are available such as, positive displacement pump, impulse pump, velocity pump, gravity pump, steam pump, valve less pump. A reciprocating pump is class of positive displacement pump, is used for variety of purpose such as, car washing, irrigation, color spraying, extraction of oil from bottom of the earth, large fountain, garden water pump, etc. This system consists of solar collector, battery, motor, crankshaft, reciprocating pump, valve, and tank. In this project work, we are planning for design and developing a solar tracking system. Providing clean, environmentally safe water for livestock in sufficient quantities continues to be a major concern for farmers and ranchers. Solar water pumping system operates on direct current. The output of solar power system varies throughout the day and with changes in weather conditions. Photovoltaic module, the power source for solar pumping, A properly designed solar pumping system will be efficient, simple and reliable. Solar powered pumping systems are used principally for three applications town and city water supply, livestock watering and irrigation.

Keywords: Solar Power, Reciprocating Pump

I. INTRODUCTION

A. Non-Conventional Energy Sources:

While fossil fuels will be the main fuels for thermal power, there is a fear that they will get exhausted eventually in the next century. Therefore other system based on non-conventional and renewable sources are being tried by many countries. These are solar, wind, geo-thermal, sea and biomass.

1) Solar Energy:

Solar energy can be major source of power. Its potential is 178 billion MW which is about 20000 times the world's demand but so far it could not developed on large scale. Sun's energy can be utilized as thermal and photovoltaic. The former is currently being used for steam and hot water production.

2) Wind Energy:

Wind energy which is indirect source of solar energy conversion can be utilized to run wind mill which in turn drives a generator to produce electricity. Wind can also be used to provide mechanical power such as for water pumping. The energy available in winds over the earth's surface is estimated to be 1.6×10^7 which is of same order of magnitude as present energy consumption on the earth.

3) Geothermal Energy:

Geothermal energy drives the heat in the Centre of the earth. According to various theories the earth has a molten core.

The facts that volcanic action takes place in many places on the surface of the earth, supports these theories. The steam and hot water comes naturally to the surface of the earth in some location of the earth. India does not appear to have any major exploitable sources.

4) Ocean Energy:

All rights reserved by Energy from seas can be utilized as wave tidal or ocean thermal energy. About 13 kW per meter height of wave can be generated. A plant to make 445000 kWh/yr. of energy is being set up in Kerala State. Ocean thermal energy conversion utilizes the temperature difference between warm surface water at about 28°C and the cold deep sea water at 5-7°C at depth of 800-1000 meter in tropical areas. In India the Gulf of Kutch, Gulf of Cambay and Sunder bans are potential sites.

5) Biomass Energy:

Biomass is another renewable source of energy in the form of wood, agriculture residues, etc. The potential for application of biomass as an alternate source of energy in India is very great. We have plenty of agriculture and forest for production of biomass. Biomass is produced in nature through photosynthesis achieved by solar energy conversion.

B. Introduction to Solar Energy:

Sun is primary source of energy, and all form of energy on the earth is derived from it. Solar energy has the greatest potential of all the sources of renewable energy and if only a small amount of this form of energy could be use, it will be one of the most important supplies of energy especially when other source in country have depleted.

Energy comes to the earth from the sun. This energy keeps the temperature of the earth above that in colder spaces, causes current in the atmosphere and in ocean, causes the water cycle and generates photosynthesis in plants.

The solar power where sun hits atmosphere is 1017 watts, whereas the solar power on earth's surface is 1016. The total worldwide power demand of all needs of civilization is 1013 watts. Therefore, the sun gives us 1000 times more power than we need. If we can use 5% of this energy, it will be 50 times what the world requires. The energy radiated by the sun in bright sunny day is approximately 1 kW/m^2 .

Utilization of solar energy is of great importance to India since it lies in a temperature climate of the region of the world's where sun light is abundant for major parts of the year. India has the total land area of $3.28 \times 10^{11} \text{ m}^2$. On an average 5 kW/m^2 per day solar energy is falling on this land over 300 days per annum.

II. PROBLEM STATEMENT

Existing reciprocating and other pumps are operated using electricity which keeps running cost of these pumps on

higher side. The cost incurred in operating the reciprocating pumps is reduced by eliminating by utilization of solar energy stored in the battery.

The position of the sun keeps on changing every day .solar panels as we know are entirely dependent on the sun. The more sunrays fall on the panels the more outcomes we get and it serves our purpose of installing a solar panel .the challenge nowadays is keep a track of the position towards sun so that we get maximum output from the panels. We hope to achieve this with a solar tracking system.

III. LITERATURE REVIEW

1) Dave Umang Y., Nena Vivek, Thakor Nirmal and Parmar Krunal.:

In this paper author has discussed about the position and purpose of photovoltaic panels and its use. The size of the PV system depends on a size of the pump and amount of water lift as well as the solar irradiance available. The paper also highlights the components and material required for construction of solar reciprocating pump. For example, solar panel-Silicon material, crank shaft-Mild steel, valve-stainless steel and tank-mild Steel.

2) Mr. Bhong Sagar, Mr. Kale Madhav, Mr. Shinde Kishorand and Mr. Bobade Rameshwar.:

In this paper author discussed about the conversion of sun energy into electrical energy in the form of DC voltage which was fed to the battery and inverter at same time. Battery stores this energy and inverter converts this DC voltage into AC voltage, which is inputted to the AC pump. Inverter is required between the PV panel and the motor to convert direct current generated by the solar panel to the alternate current required for electric pump motor.

3) *Concluding Remark:*

- 1) From the paper entitled "Solar Powered Reciprocating Pump" it seems that the size of PV panel depends on size of pump, amount of water to be lifted and solar irradiance available. This paper is also useful for selection of materials for different components of our solar reciprocating pump.
- 2) The sun energy is converted into DC current by using Solar Panel.

IV. DESIGN

A. Working Principle:

Reciprocating pump is a positive displacement pump, which causes a fluid to move by trapping a fixed amount of it then displacing that trapped volume into the discharge pipe. The fluid enters a Pumping chamber via an inlet valve and is pushed out via outlet valve by the action of the piston. They are either single acting; independent suction and discharge strokes.

During the suction stroke the piston moves left thus creating vacuum in the Cylinder. This vacuum causes the suction valve to open and water enters the Cylinder. During the delivery stroke the piston moves towards right. This increasing pressure in the cylinder causes the suction valve to close and delivery to open and water is forced in the

delivery pipe. The air vessel is used to get uniform discharge.

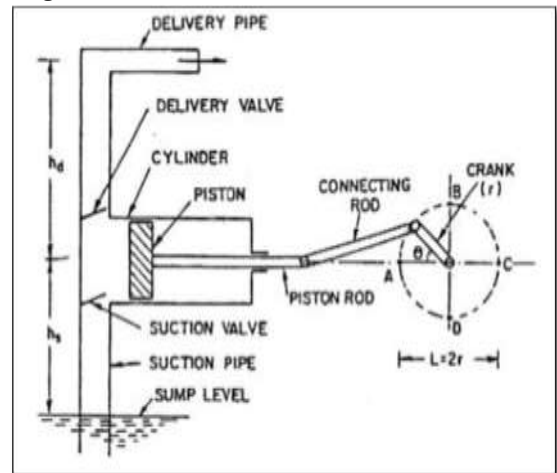


Fig. 1: Principal of Reciprocating Pump

Reciprocating pumps are self-priming and are suitable for very high heads at low flows. They deliver reliable discharge flows and is often used for metering duties because of constancy of flow rate. The flow rate is changed only by adjusting the rpm of the driver. These pumps deliver a highly pulsed flow.

B. Parts

- 12Volt 50Watt Polycrystalline Solar panel
- 12 Volt Battery
- 12 Volt Dc Motor With Speed Reduction Gearbox (15 RPM)
- Circular Disc
- Connecting Rod
- 50mm Dia.& 200mm Stroke Reciprocating Pump
- Supply pipes
- Sump and overhead tank
- Base for supporting the system

C. Working

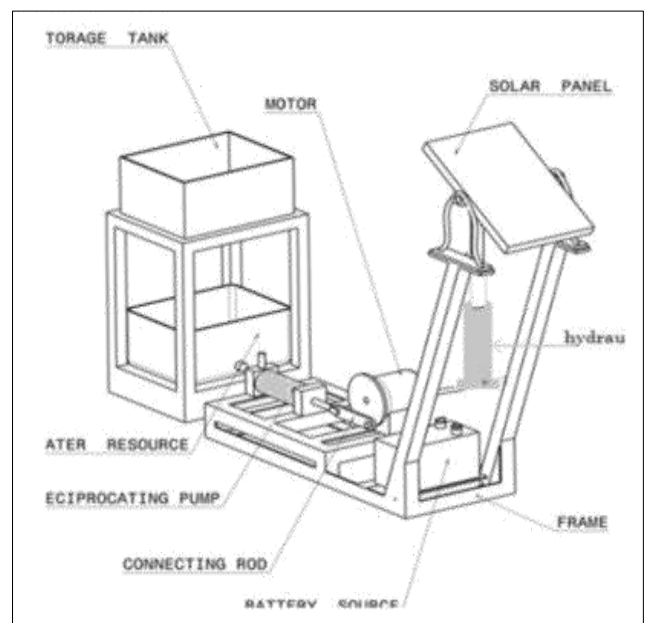


Fig. 2: proposed diagram

The first solar panel photovoltaic cell is power generate for using is sun rays. This energy transfers the Storage battery and again transfers the dc motor. The dc motor end shaft of connect crank and crank to connecting rod in power transmitted. Last the connecting rod to reciprocating pump power transmitted. The dc motor is rotary motion to converting linear motion for reciprocating pump. Reciprocating pump is water supplied for bottom to higher level tank.

V. MATERIAL SELECTION

Selection of the material depends upon factor of safety, which depends upon the following factors such as reliabilities of properties, reliability of applied load, and the certainty as to exact mode of failure of localized, the extent of initial stresses setup during manufacturing.

Sr. No.	COMPONENTS	MATERIAL
1	Solar panel	Silicon
2	Battery	-
3	Crank shaft	Mild Steel
4	Motor	-
5	Valve	Stainless Steel
6	Tank	Mild Steel
7	Reciprocating Pump	Plastic
8	Pipe	Stainless Steel
9	Stand	Mild Steel

VI. FABRICATION

- 1) First we will cut the hollow square bar according to necessity. Then we convert it into the frame, 4 base parts and 2 long section of rod put into the top of the frame for the mounting the motor and cylinder.
- 2) For the mounting motor and cylinder on the frame we can drill the bar with numbers of hole on it, for fitting the motor and cylinder on the frame with the help of nut and bolt.
- 3) Then we can cut the square plate and convert it into the circular section or shape, then the drill was pass out into the center of the that circle. next that circular section is fitted with the motors shaft with key ways arrangement on that same plate we can drill one hole simultaneously, and we can use one short rod because the linkage in between circular plate and the piston cylinder arrangement for smooth transmitting the power of motor into the cylinder

VII. RESULT

The number of rotation per minute will be 10. As the disc will complete one rotation, one stroke of the piston will be completed. It has been observed that approx. one liter of water is delivered to the required head at the end of fourth stroke. That means the discharge is equal to 2.5 liters per minute.

RPM= 10

Discharge in one stroke= 0.25 liter per minute

No of rotation = No of stroke

So, Total Discharge $0.25 \times 10 = 2.5$ liter/minute

VIII. CONCLUSION

The method used here to build solar powered water pumping system is cost effective comparatively to an electrically operated hydraulic pump. Since here non-conventional energy is used to achieve the required head.

Discharge obtained from the observations is 2.5 liters per minute. The reciprocating pump built by us is built with the help of simple and easily available materials still we have successful to demonstrate the worth of a reciprocating pump. This device serves its purpose to some extent, but with proper course of actions, it can perform still better.

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