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E-Mail :
editor.ijasem@gmail.com
editor@ijasem.org

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Solar-Powered Reciprocating Pump

Perumallapalli Gandhi [1], Dr G Raja Kumar [2], Dr. B. Ravi [3]
Assistant Professor [1,2,3]
Department of Mechanical engineering,
[1] SV engineering college, Surya Peta (DIST). TS-508213
[2,3] Swarna Bharati Institute of Science and Technology, Khammam, TS-507002

ABSTRACT:

Rural regions, where India's vital organs are located, rely on the agriculture industry for vital services. To strengthen the agricultural economy, it is vital to improve irrigation systems. In order to power modern conveniences, more energy is required. Central pumps and fuel-based pumps may be replaced with solar energy, which, if used well, can minimise power consumption and environmental impact. We want to discharge more water from our resources in the end. Powering a DC motor using energy stored in batteries and solar photovoltaic (PV) panels, a connecting rod then powers a reciprocating pump. Battery packs, engines, crankshafts, fluid exchange pumps, valves, and storage tanks are all part of the system.

Keywords:

Direct Current (DC) Motor with Gear Box for Solar-Powered Reciprocating Water Pump.

INTRODUCTION

Section A: Alternative Energy Sources: Even though fossil fuels will be the main source of thermal power, there is apprehension that these supplies would be depleted in the future century. For this reason, several countries are trying out innovative systems that use renewable energy and other unconventional resources. The ocean, bio-mass, solar radiation, wind, and geo-thermal are all part of this category.
Power from the Sun:
Solar power is one possible energy source for large-scale projects. Despite its capacity of 178 billion MW—roughly 20,000 times the world's consumption—its large-scale development has not been viable. Solar power has the potential to be converted into thermal and photovoltaic energy. The first one is now heating water and steam.

Reciprocating pumps that are powered by the sun's energy are an alternative to traditional pumps that rely on electricity or diesel. There is an overwhelming variety of pumps available today. Relocation Encouraging Program A positive pump is an example of a reciprocating pump. It serves several purposes. Considerations abound, including initial and continuing costs, water use, system capacity, oil extraction, sprinkler technology, irrigation, and spraying. Integrating solar electricity with other renewable energy sources is being considered for potential application due to the long-term and financial benefits it offers.

TheApplicationofSolarEnergy:

- Waterforlivestock.
- DrinkingandCookingWaterSupply.
- Solardryingofagriculturalandanimalproducts.
- .Industriesandcommercialuses.
- Solarenginesforwaterpumping.
- Foodrefrigeration.
- Solarelectricpower generationbysolarponds,steamgenerator.
- Solarphotovoltaiccells.

LITERATUREREVIEW

Malawi Solar Powered Water Pump System BY:-HunterKing1andDr.AndreButler2:

- ABSTRACT:

An orphanage in the Chuluchosema village in Malawi, Africa, will have access to drinkable water thanks to this project's water pumping system. The orphanage centre has a water tower that

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will be filled with water from a nearby well. The pump will be run by harnessing the energy of the sun using a solar panel. This endeavour is being carried out in collaboration with Mercer on a Mission and the Master of Science in Environmental Engineering program at Mercer University. The water pump system will be constructed on the Mercer campus and thereafter transported to the Malawian orphanage for long-term assembly. The materials used to construct the water pumping system are environmentally friendly enough to ensure the system continues to work effectively even after the student has departed. Working with a variety of lecturers, producers, and connections from the developing countries, this initiative aims to provide the graduate student practical experience. Providing an orphanage with drinkable water without requiring its inhabitants to dig a well is the primary objective of this initiative.Search Terms: Solar Water Pump in Malawi.

Experimental Study Of Solar Water Pump BY:-Master of Science Erin Williamson:

Our First Solar-Powered Water Pump Test Posed by Erin Williamson, a doctoral candidate in the field: - AIn a nutshell:

Managing Bioresources Investigations into solar water pump research for small-scale irrigation Irrigation is an established practice on a worldwide scale and among many farms in western Canada. It allows for more crop diversity while increasing agricultural production. Nevertheless, traditional energy is significantly used due to the usage of electric motors and fuel-powered generators in the majority of irrigation systems. The main objective of this research was to find out whether photovoltaic (PV) modules could power a small-scale drip irrigation system in Montréal (Québec, Canada). Data from PV systems in the actual world and models simulating solar radiation and electricity generation throughout the globe were both used in the study. Over the course of the summer and winter field measurements, two 42 W PV modules constructed of amorphous silicon were set up. A 12 V surface water pump was immediately connected to them. Some of the metrics that were monitored at the back of the panel were flow, pressure, voltage, current, and temperature. These measured quantities were used to determine the PV electrical output and the amount of pumped water. The models of solar radiation and PV electrical production were informed by the following meteorological data: daily average, maximum, and minimum temperatures; global solar radiation; site latitude, elevation, and panel tilt. The projected daily levels of solar radiation were 0.69 percentage points more than the actual daily values between 2000 and 2005. A correlation value of 0.91 was achieved after a 7-day average of the actual and predicted solar radiation data. Measurements of water pushed and PV electricity generation were taken from August 2005 to May 2006. Both the water production and the electrical generation were determined to be lower than expected. The predicted daily PV power output, however, ranged from 0.6 MJ d-1 in winter to 1.0 MJ d-1 in summer. A rise in the volume of water propelled by an increase in power is not unexpected.

METHODOLOGY

Asolarpoweredwaterpumpingsystemismadeupof twomaincomponents,

1) Solarpanels:
   – Photovoltaicmodule
2) Pumps:
   – Centrifugal
   – Reciprocatingpump

Therearetwobasictypesofsolarpoweredwaterpu mpingsystems,

1) Batterybased
2) Solardirect

– Avarietyoffactors mustbeconsideredindeterminingtheopti mumsystemforaparticularapplication.
– Batterybased waterpumpingsystemconsi stsofphotovoltaic(PV)pane lschargecontroller,batterie s,pumpcontrollerand DCwaterpump,

1) Watersupplyforhomeorcabin.
2) Pumpingatnight

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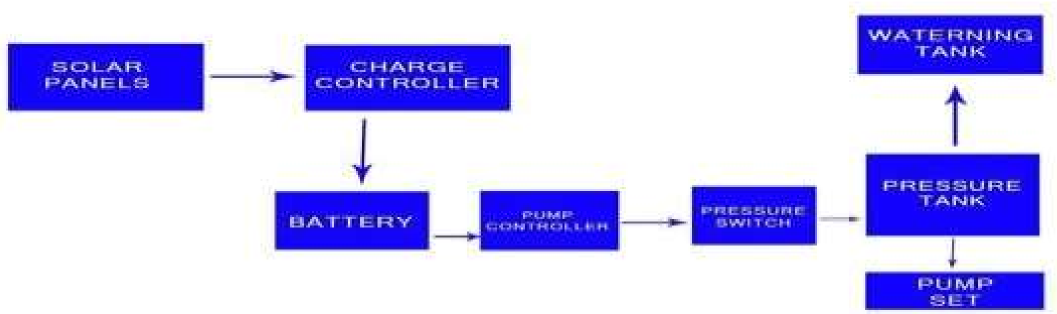

The diaphragm, pistons, or plungers of a reciprocating pump oscillate in a predetermined rhythm to transfer fluid.A "reciprocate" motion is one that goes in both directions. The term "RECIPROCATING" is therefore used to describe a pump that is bidirectional. The most basic kind of reciprocating pump, the "Bicycle Pump," is something that most people have used while inflating their bike tires. For reciprocating-type pumps, a set of suction and discharge valves is required to ensure that fluid moves in a positive direction. The number of cylinders in a pump belonging to this class may range from one (the "simplex") to four (the "quad"). Most reciprocating pumps have cylinders that are either "duplex" or "triplex" in design. Another kind of stroke is the "single acting" stroke, which only suctions one way, whereas the "double acting" strokes discharge in both directions. Depending on the application, the pumps may be driven by air, steam, or a belt system. When steam propulsion was at its peak in the early 1900s, these boiler feed water pumps were widely used. In modern times, reciprocating pumps have replaced alternative methods for transporting thick fluids like concrete and heavy oils, as well as for some applications requiring low flow rates in the face of considerable opposition.

Fig.1:Solarpowerreciprocatingpump

A. A reciprocating pump, which is a kind of positive displacement pump, transfers fluid by taking in a constant amount of the fluid and then releasing it via the output pipe. To drive fluid out of a pumping chamber, a piston or diaphragm pushes on an outlet valve, which is connected to an entry valve. Both suction and discharge may be accomplished at the same time with double-acting models, whereas single-acting models allow for both functions to be performed independently.

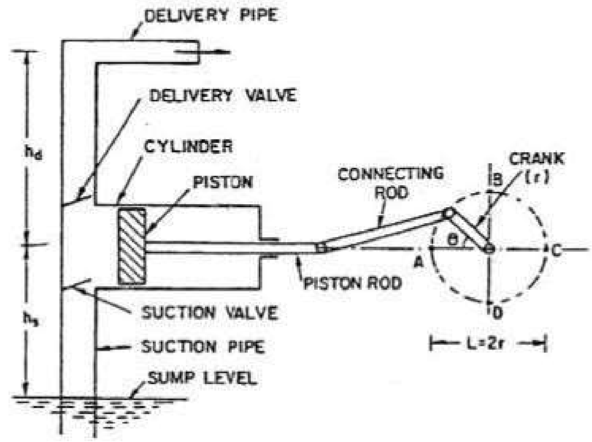

Fig.2:ReciprocatingPump

During the suction stroke, the piston moves to the left, creating a vacuum in the cylinder. The vacuum triggers the opening of the suction valve, which lets water into the cylinder. During the delivery stroke, the piston moves to the right. The suction valve closes and the delivery valve opens in response to an increase in cylinder pressure, allowing water to be forced into the delivery line. The purpose of the air vessel is to provide a constant outflow.

A self-priming reciprocating pump is ideal for applications with very high heads and low flows. They reliably provide discharge flows and have a constant flow rate, making them perfect for metering jobs. Only by adjusting the driver's rotations per minute is the flow rate variable.

Pulsating is the best way to describe the flow these pumps generate. To provide a continuous flow, the discharge flow system must have accumulators and other components installed. An automatic relief valve, pressure-set to a safe level, is located on the discharge side of every positive displacement pump. The net head h is a performance metric for pumps that describes the change in Bernoulli head between the suction and delivery sides of the pump. The water column height equivalent is used to express the value of H.

The purpose of the air vessel is to provide a constant outflow. A self-priming reciprocating pump is ideal for applications with very high heads and low flows. They reliably provide discharge flows and have a constant flow rate, making them perfect for metering jobs. The use of a connecting rod allows for the straightening of a piston. A vacuum is created within the cylinder as the crank is rotated outward, which forces the piston to move to the right. Only by adjusting the driver's rotations per minute is the flow rate variable. Pulsating is the best way to describe the flow these pumps generate.

To provide a continuous flow, the discharge flow system must have accumulators and other components installed. An automatic relief valve, pressure-set to a safe level, is located on the discharge side of every positive displacement pump. The net head h is a performance metric for pumps that describes the change in Bernoulli head between the suction and delivery sides of the pump. H stands for the same column height of water.

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II. Parts

- 10WATTSOLARPANNEL
- 12VOLTBATTERY
- 12VOLTMOTORWITHSPEEDREDUCTIONGEARBOX
- CIRCULARDISC
- CONNECTINGROD
- PISTONCYLINDER
- SUPPLYPIPES
- SUMPANDOVERHEADTANK
- BASEFORSUPPORTINGTHESYSTEM

III. Operations

A. *ProcurementofMaterial:*

1) Pneumatic pump: - Instead of hydraulic pump over here pneumatic pump is used to reduce the cost of pump. Thedimensions of the pump are 50mm * 100mm. At one end silencer is provided and by providing a branch tee at anotherend suction and discharge is provided. Forward motion of the piston is used for discharge and backward is used for thesuctionofwaterfromthesump.
2) Dc Motor with speed reduction gear box: -12volt dc motor with torque magnification gear box is used to provide highstartingtorque tothe diskandspeedisreduced.
3) 10WattSolarpanel:- A10wattsolarpanelisusedtoconverttheincidentsolarenergyintoelectricityofrequiredamount.
4) One12vbattery: -One12batteryisconnectedinseriestoobtain12voltoutput.
5) Pipe:-Flexiblepipeof8mm*12mmis usedforsuctionfromsumpanddeliverytotheoverheadtank.

B. *Calculation*

L= LENGTH OF STROKER=RADIUSOFTHEDISC.L=2R L=150mm,thusradiusis L/2=50mm.Thusdiameterofthediscis100mm.

1) Disc:-Thecirculardiskof120mmdiameterand3mmthicknessisusedtoconvertrotarymotionofthe gearboxtoreciprocating motionforpistonandcylinder.
2) Connectingrod:- Aconnectingof220mmisusedtoconnectthediskandthepistonwithaspecialattachmenttoprovidereciprocatingmotion.The center hole distance is250mm.

Resultanalysis

A. *TheoreticalCalculations:*

LossesIgnored
Bore Diameter= 50mmLength of stroke=

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100mmHea
dor
heighth=3.5
mSpeed of
rotationN=1
5rpm Pipe
Dia=
8mmPipeLe
ngth=2m
Suctionlift=0.5m

$Q=\pi\times d^2\times L\times N=\pi\times(0.05)^2\times 0.01\times 15=4.90\times$
$10^{-6}m^3/s$ 4×60 4×60

$P=\rho\times g\times h=1000\times 9.81\times 3.5=1034.3pa$

Maxspeed(piston)=$\omega\times r=\frac{2\times\pi\times N\times r}{60}=0.07m/s$

max velocity of water in delivery pipe

$=\frac{0.07\times 0.05^2}{0.008x0.008}$

$= 2.73m/s$

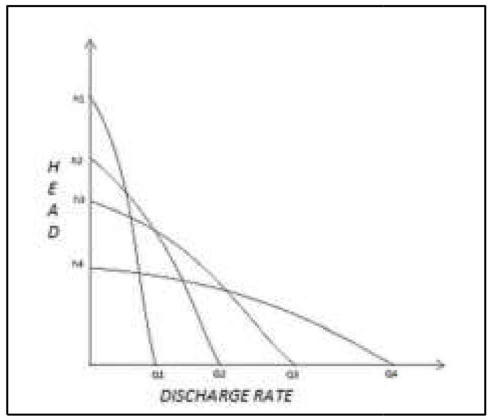
Head loss friction $-\frac{2\times\rho\times L\times V^2}{g\times D}$

SupplyInertia head= $L\times d^2\times\omega^2\times r$

$=\frac{3.5\times .05^2\times 1.4^2\times .05}{9.8\times 0.009}$

$= 1.05m$

SuctionInertiahead= -0.26m



B. PracticalCalculation:

AccordingtoobservationstheDiscisrotatingfromTDCtoBDCin2secsthatmeansonecompleterotationwillbeoccurringin4sec.
Sothenumberofrotationperminutewillbe15.Asthediscwillcompleeonerotation,onestrokeofthepistonwillbe completed.Ithasbeenobservedthatapprox.oneliterofwaterisdeliveredtotherequiredheadameansthe discharge isequal to2.7 litersperminute.

RPM=15

Discharge in one stroke= 0.27 liter

perminuteNoofrotation=Noof stroke

So,TotalDischarge$0.27\times 15=4.05$liter/minute

GraphofRelationbetweenDischargeandHead:

ADVANTAGESANDDISADVANTAGE

Part A: Advantages - Solar water systems might be a practical option in places with flat terrain and sufficient sunshine.

To distribute water to places that need it, solar-powered water pumps may be set up in or near water sources, such as ponds. Solar water pumping is an excellent choice since it is clean and efficient.

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Solar electric water pumping decreases waste since it relies on natural cycles. Your panels will generate the most electricity for pumping water on sunny days, when your demands are highest.
- A No pollution is caused by solar power. There will be no contamination of groundwater or air when a gas-powered pump is used.
Solar water systems need little maintenance due to the low number of moving parts. Their average lifespan is twenty to forty years. Solar water systems may generate energy indefinitely, provided that the sun keeps shining.
B. Cons: - High initial investment - Minimal output on cloudy days

CONCLUSION

In this case, the solar pumping system is more cost-effective than hydraulic pumps powered by electricity. Because in this instance, the required head is achieved by non-conventional energy techniques. A flow rate of 2.7 litres per minute is shown by the data. Our reciprocating pump has shown to be valuable despite being built using cheap and easily available components. This tool is functional, but with proper use, it has the potential to be much more successful.

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