Solar Power Reciprocating Pump

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ABSTRACT:

Rural India is where India's heart and soul are, and agriculture is the industry that supports rural India. Strengthening the economic foundation in agriculture requires an upgrade to irrigation systems. Nowadays, individuals need more power to operate modern machinery. To realise its potential as an eco-friendly alternative to central pumps and fuel-based pumps that uses less electricity while operating, solar energy must be used at its highest efficiency. The end goal is to increase the amount of water that is released via water resources. Solar photovoltaic (PV) panels and batteries store energy for later use; this energy powers a direct current (DC) motor, which in turn powers a reciprocating pump via a connecting rod. Solitary solar panels, batteries, motors, crankshafts, exchange pumps, valves, and tanks make up the system.

Keywords:

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

INTRODUCTION

Section A: Alternative Energy Sources: Although thermal power will primarily use fossil fuels, there is concern that these resources may run out during the next century. Consequently, a lot of nations are experimenting with alternative systems that rely on renewable energy and other non-traditional sources. These include bio-mass, the sun, the wind, geo-thermal, and the ocean. #1) SolarPower: One potential large-scale energy source is solar electricity. It has not been feasible to develop it on a significant scale despite having a potential of 178 billion MW, which is about 20,000 times the world's consumption. Thermal and photovoltaic energy may be harnessed from the sun. The former is now producing steam and hot water. In contrast to conventional pumps that use electricity or diesel power, solar-based reciprocating pumps use the energy of the sun's rays to fuel their operation. These days, there are a plethora of pump options. Reward-Based Relocation One kind of positive pump is the reciprocating pump. It has several functions. There are a lot of factors to consider, including the original and ongoing expenditures, water consumption, system capacity, oil extraction, sprinkler technology, irrigation, and sprinkling. Because of the long-term and financial advantages they provide, solar powered systems are being examined for usage with other alternative energy sources.

TheApplicationofSolarEnergy:

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

LITERATUREREVIEW

MalawiSolarPoweredWaterPumpSystem BY:-HunterKing1andDr.AndreButler2:

– ABSTRACT:

This project will consist of a water pumping system to supply potable water to an orphanage located in the Chuluchosemacommunity of Malawi,Africa. Thewaterwill be pumpedfrom anearby well up to a water tower located in the orphanagecenter. The pump will be powered by a solar panel that will capture the solar energy from the sun. This project is in associationwith Mercer's University's Master's Program for Environmental Engineering and Mercer on a Mission. The water pump systemwill be built on Mercer's campus and will then be sent to the orphanage in Malawi to be assembled permanently. The waterpumping system will be built by materials that are sustainable enough to allow the system to function properly long after thestudent has installed the system and has left. The intent of this project is to provide a hands-on experiencefor thegraduatestudent by working with various professors andmanufacturers as well as different contacts from the developing country. Thegoal of this project is to supply potable water to an orphanage without the residents retrieving it from a well.Keywords: MalawiSolar WaterPump.

ExperimentalStudyOfSolarWaterPumpBY:-MasterofScienceErinWilliamson:

A Solar Water Pump Experiment Written by Erin Williamson, a Master of Science: -Brief Summary: Bioresource Management Research on small-scale irrigation using solar water pumps Many farms in western Canada use irrigation as a standard operating method, and it's also used on a global scale. It increases agricultural yields while allowing for crop variety. The use of electric motors and fuel-powered generators in most irrigation systems, however, results in a significant consumption of conventional energy. The overarching goal of this study was to ascertain whether or not a small-scale drip irrigation system in Montréal (Québec, Canada) could be powered by photovoltaic (PV) modules. The research included both real-world data collected from PV systems and theoretical models that simulated the world's solar radiation and electrical production. During the field observations, two 42 W PV modules made of amorphous silicon were installed during the summer and winter. They were linked directly to a 12 V surface water pump. Flow, pressure, voltage, current, and temperature at the panel's rear were among the metrics tracked. The PV electrical output and volume of pumped water were calculated using these measured values. Using the following meteorological data: daily average, maximum, and minimum temperatures; global solar radiation; site latitude, elevation, and panel tilt were input into the models of solar radiation and PV electrical output. From 2000 to 2005, the predicted daily sun radiation levels were 0.69 percentage points higher than the actual daily readings. When the actual and anticipated solar radiation statistics were averaged across 7 days, the correlation value improved to 0.91. From August 2005 through May 2006, the amount of water pushed and the electrical production of PV were tracked. It was found that the water production and electricity output were lower than anticipated. Nevertheless, the anticipated daily PV electricity production varied from about 0.6 MJ d-1 in the winter to 1.0 MJ d-1 in the summer. It was not surprising that the amount of water pushed increased when power was increased.

METHODOLOGY

Asolarpoweredwaterpumpingsystemismadeupof twomaincomponents,

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

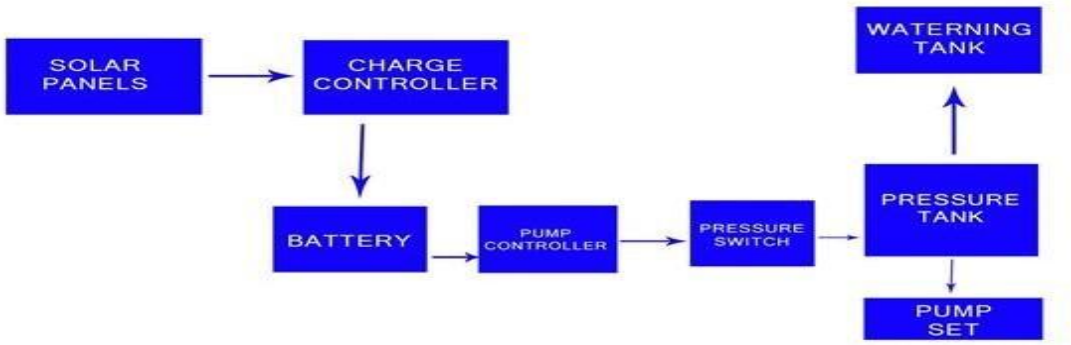
Therearetwobasictypesofsolarpoweredwaterpumpingsystems,

1) Batterybased
2) Solardirect

– Avarietyoffactors mustbeconsideredindeterminingtheoptimumsystemforaparticularapplication.
– Batterybased waterpumpingsystemconsistsofphotovoltaic(PV)panelschargecontroller,batterie

s,pumpcontrollerand DCwaterpump,

1) Watersupplyforhomeorcabin.
2) Pumpingatnight



One kind of pump is the reciprocating pump, which moves the fluid by use of a diaphragm, pistons, or plungers that oscillate in a certain pattern.Moving backwards and forth is what the word "reciprocate" signifies.

Therefore, a pump that can work in both directions is called a "RECIPROCATING" pump. Anyone who has ever re-inflated their bike tyres has likely used the "Bicycle Pump," the simplest kind of reciprocating pump. To guarantee that fluid travels in a positive direction, a set of suction and discharge valves is necessary for reciprocating-type pumps. Pumps that fall under this category might have anything from one cylinder (the "simplex") to four cylinders (the "quad"). "Duplex" or "triplex" cylinders are the most common design for reciprocating pumps. They may also be "double acting" strokes that suction and discharge in both directions, or "single acting" strokes that suction and discharge independently. Air, steam, or a belt drive from a motor or engine may power the pumps. Boiler feed water pumps of this sort saw considerable usage throughout the early 1900s, when steam propulsion was at its height. Nowadays, reciprocating pumps are the go-to for moving concrete, heavy oils, and other thick fluids, as well as for specific tasks that need low flow rates despite strong resistance.

Fig.1:Solarpowerreciprocatingpump

A.As a kind of positive displacement pump, a reciprocating pump moves fluid by first capturing a fixed volume of the fluid and then releasing that volume via the output pipe. A pumping chamber has an entrance valve that fluid flows into, and an outlet valve that the fluid is forced out of by means of a piston or diaphragm. They may be either double-acting, which allows for simultaneous suction and

discharge, or single-acting, which allows for separate suction and discharge.

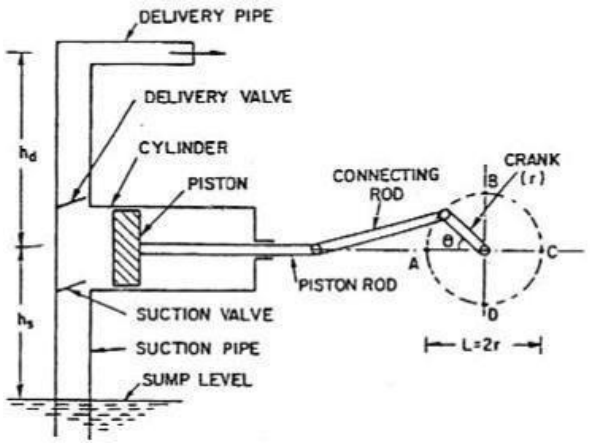


Fig.2:ReciprocatingPump

A vacuum is created in the cylinder when the piston advances to the left during the suction stroke. The suction valve opens due to the vacuum, allowing water to enter the cylinder. The piston travels to the right during the delivery stroke. As the cylinder pressure rises, the suction valve shuts and the delivery valve opens, forcing water into the delivery line. To provide a consistent discharge, the air vessel is used.

When dealing with very high heads at low flows, a self-priming reciprocating pump is the way to go. Their consistent flow rate makes them ideal for metering tasks, and they consistently supply dependable discharge flows. The only way to vary the flow rate is to adjust the driver's revolutions per minute.

The flow that these pumps produce is quite pulsated. The installation of accumulators and other elements to the discharge flow system is necessary to provide a smooth flow. Every positive displacement pump has an automated relief valve on the discharge side that is pressure-set to a safe level.
The change in Bernoulli head between the pump's suction and delivery sides is known as the net head h, and it is a measure of the pump's performance. The value of H is given in terms of the water column height equivalent.

To provide a consistent discharge, the air vessel is used. When dealing with very high heads at low flows, a self-priming reciprocating pump is the way to go. Their consistent flow rate makes them ideal for metering tasks, and they consistently supply dependable discharge flows. A piston in a straight line may be achieved by attaching it to a connecting rod. When the crank is turned outward, the piston is forced to travel to the right, resulting in the creation of vacuum inside the cylinder. The only way to vary the flow rate is to adjust the driver's revolutions per minute. The flow that these pumps produce is quite pulsated.

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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=R
ADIUSOFTH
EDISC.L=2R
L=150mm,thusradiusis
L/2=50mm.Thusdiamet
erofthediscis100mm.

1) Disc:-Thecirculardiskof120mmdiameterand3mmthicknessisusedtoconvertrotarymotionofthe gearboxtoreciprocating motionforpistonandcylinder.
2) Connectingrod:- Aconnectingof220mmisusedtoconnectthediskandthepistonwithaspecialattachmenttoproviderecipr ocatingmotion.The center hole distance is250mm.

RESULTANALYSIS

A. TheoreticalCalculations:

LossesIgnored
Bore
Diameter=
50mmLengt
h of stroke=
100mmHea
dor

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

$Q=\pi\times d^2\times L\times N=\pi\times(0.05)^2\times0.01\times15=4.90\times 10^{-6}m^3/s4\times60 \quad 4\times60$

$P=\rho\times g\times h=1000\times9.81\times3.5=1034.3pa$

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

max velocity of water in

$$\frac{\text{delivery}}{\text{pipe}}=\frac{0.07\times0.05^2}{0.008x0.008}$$

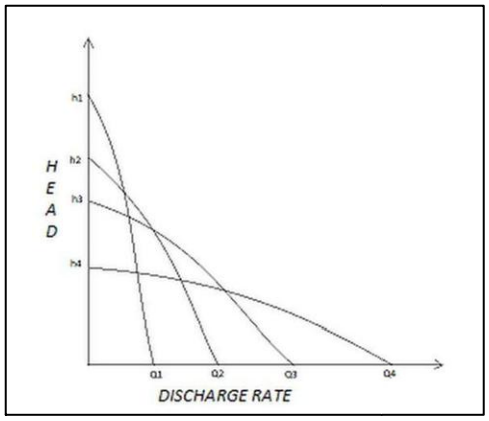
$= 2.73m/s$

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

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

$=3.5\times.05^2\times1.4^2\times.05$
9.8×0.009
$= 1.05m$

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,TotalDischarge0.27×15=4.05liter/minute

GraphofRelationbetweenDischargeandHead:

ADVANTAGESANDDISADVANTAGE

A. Pros: - In areas with level terrain and enough sunlight, solar-powered water systems are a feasible choice.

Solar-powered water pumps may be installed in or near water sources like ponds to transport water to areas that need it.

Clean and efficient, solar water pumping is a great option.

Due to its reliance on natural cycles, solar electric water pumping reduces waste. On days with the most sunshine, when your water needs are greatest, your panels will provide the maximum pumping power.

- ASolar electricity doesn't pollute. Using a gas-

powered pump eliminates the risk of groundwater and air pollution.
Because there aren't many moving components in solar water systems, they need little upkeep. They often live for 20 to 40 years. As long as the sun continues to shine, solar water systems will never run out of fuel.

B. Drawbacks: - Expensive starting price - Slightly reduced production on overcast days

CONCLUSION

When compared to hydraulic pumps that are driven by electricity, the solar pumping system that was constructed here is the more economical option. Because in this case, the necessary head is accomplished by means other than conventional energy.
The data indicates a discharge rate of 2.7 litres per minute. Even though our reciprocating pump is constructed using inexpensive and readily accessible components, we have managed to prove its value. This tool gets the job done, but it may be far more effective if used correctly.

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