Review and Analysis of Solar Water Pump

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Abstract: Solar electricity is the technology where sunlight directly produces electricity based on photovoltaic or solar module. It is based on solar cell where do not require any fuel. Our main objective is to design and develop a solar water pumping system. Main components of solar water pumping system are solar panel, controller and pump. Other control mechanism carries inverter, battery, module structure .The efficiency of the system is improved with a maximum power point tracker (MPPT) and a sun-tracker. Agricultural applications suitable for photovoltaic (PV) solutions are numerous. The applications are basically mixture of individual installations plus systems installed by effectiveness companies when they have found that a PV solution is the unsurpassed solution for remote agricultural need such as water pumping for crops or livestock.

Keywords: Water Pump; Solar PV Cell; Solar Panels; Solar Batteries

1. Introduction

A Solar-Powered Pump be a pump operation on electricity generated by solar photovoltaic panels available from collected sunlight as opposed to grid electricity or diesel run water pumps. The operation of solar powered pumps be more economical mostly due to the lower operation and maintenance (preservation) costs and has less environmental impact than pumps powered by an Internal Combustion Engines (ICE). Solar pumps are useful wherever grid electricity be unavailable and alternative sources (in particular wind) do not provide sufficient energy.

2. LITERATURE REVIEW:

Andrews, John W. entitled "Hot water tank for use with a combination of solar energy and heat-pump de superheating" in observation that "A water heater or system which includes a hot water tank having disposed therein a movable baffle to function as a barrier between the incoming volume of cold water entering the tank and the volume of heated water entering the tank which is heated by the circulation of the cold water through a solar collector and/or a de super heater of a heat pump so as to optimize the manner in which heat is imparted to the water in accordance to the demand on the water heater or otherwise system. A supplemental heater is also provided and it is connected so as to supplement the heating of the water in the event that the solar collector and/or de super heater cannot impart all of the desired heat input into the water" **[1].**

Zhongchao Zhao; Yanrui Zhang; HaojunMi; Yimeng Zhou; Yong Zhang entitled "Experimental Research of a Water-Source Heat Pump Water Heater System" that "The heat pump water heater (HPWH), as a portion of the eco-friendly technologies using renewable energy, has been applied for years in developed countries. Air-source heat pump water heaters and solar-assisted heat pump water heaters have been widely applied and have become more and more popular because of their comparatively higher energy efficiency and environmental protection. Besides use of the above resources, the heat pump water heater system can also adequately utilized as an available water **[2]."**

Klit, Peder; Olsen, Stefan; Bech, Thomas NA entitled "Design of Pumps for Water Hydraulic Systems" that "This paper considers the development of two pumps for water hydraulic applications. The pumps are based on two different working principles: The Vane-type pump and the Gear-type pump. Emphasis is put on the considerations that should be made to account for water as the hydraulic fluid **[3]."**

Harlamert, P.; Kennard, J.; Ciriunas, J. entitled "Solar Water-Heater Design and Installation" that "Solar/Water heater system works as follows: Solar--heated air is pumped from collectors through rock bin from top to bottom. Air handler circulates heated air through an air-to-water heat exchanger, which transfers heat to incoming well water. In one application, it may reduce oil use by 40 percent **[4]".**

Seyitkurbanov, S; Kerimov, E entitled "Solar water lifter" that "A water lifter is described which contains a steam generator with easily boiling fluid and capacitor connected to the working chamber equipped with an elastic container and connected to the pumping chamber having a pressure pipeline. In order to improve efficiency, the capacitor is arranged pressure pipeline **[5]".**

Klockgether, J.; Kiessling, K. P. entitled "Photovoltaic pump systems" that "Solar pump systems for the irrigation of fields and for water supply in regions with much sunshine are discussed. For surface water and sources with a hoisting depth of 12 m, a system with immersion pumps is used. For deep sources with larger hoisting depths, an underwater motor pump was developed. Both types of pump system meet the requirements of simple installation and manipulation, safe operation, maintenance free, and high efficiency reducing the number of solar cells needed **[6]".**

Man Djun Lee, Pui San Lee, Jasper Ling, and Heng Jong Ngu entitled "Design and Development of Renewable Energy Water Pump" that "This study aims to develop a water pump that utilizes natural hydro energy as driving force to deliver water to a higher ground. The conceptual design of using water wheel to extract kinetic energy from water flow, and transfer the energy to power multiple piston pump was created based on the extensive literature review findings. The actual prototype is then built and modified to suit the actual environment considerations. Findings show that single pump is able to produce maximum pressure head of 7.14 m and the maximum volume flow rate achieved is 19.2 l/h (320 ml/min). However, when multiple flow rate about 19.2 l/h. This result shows that the water pump can be used in remote area or places at higher ground that does not have constant water access., steeper angle and better piston shaft design for water pump, and also proper water sealing of the whole system to prevent head loss and increase the overall performance piston is connected in series (in this research three pistons is used), the maximum water head increased to 13.77 m and the maximum volume **[7]".**

3. Main Components of Solar Water Pump:

3.1. Water pumps:

A water pump is a significant component of any water pumping system. There are several kinds of water pumps, including the submersible water pumps, circulation pumps, booster pumps and sump pumps.

3.2. **Submersible pumps:** These pump water from great depths such as underground water sources like boreholes and shallow wells.

3.3. **Surface pump:** By this pump underground water comes from near about 20 feet depth.

Figure No. 1: Uganda commissions solar powered irrigation scheme

3.4. Solar Panels:

A solar panel is the main component of the solar water pumping system. A group of solar panels is known as an Array. A solar panel creates electricity by allowing photons, light rays to knock electrons free from atoms and hence generate electricity. A solar panel comprises of other smaller units known as photovoltaic cells which convert sunlight to electricity. There exist different types of solar power technology, such as solar thermal and concentrated solar power. These operate in a way different from photovoltaic solar panels. However, they also harness the power of sunlight to create electricity used to run the water pumps.

Figure No. 2: Solar irrigation Pump

3.5. Solar Batteries:

Batteries store the charge generated by the solar panels. Throughout the day, electricity generated by the solar panels be complete to the battery and the load. When the load demand be higher than the energy inward from the solar panels, these batteries will afford stable power to the pumping systems. Batteries ensure that the water pumping systems run whether the sun shines or not.

3.6. Pump Controllers:

Pump controllers customise the parameters of the pumping systems to fit the user's requirements and also protect the pumping systems. They can be used to set a pumping schedule for the water. The practice of scheduling water helps to maximise the lifespan of the water pump.

Figure No. 3: Pump Controllers

3.7. Solar Inverters:

Inverters convert direct currents (DC) to Alternating Current (AC). The conversion of DC to AC is necessary for several electrical devices, including the Water pumps. Consequently, this makes an inverter an essential component of the water solar pumping system. However, the use of DC pumps eliminates the requirement of inverters. During cloudy and low light days, the inverter is a high power back up keeping your water pumps running even without solar. If you are considering investing in solar water pumping systems, the knowledge about these components gives you a clear picture of what you are investing in and their benefits versus the cost

4. How to select a solar pump ??

Different water pump types are used for different applications. Usually, the water level will determine which pump to use. Different types of water pumps can be selected to be used in streams, wells or in ponds. There are basically two types of solar water pumps: 1. Submersible water pumps can be used to lift water from great depths of up to 700feet deep 2. Surface water pumps can be used to pump surface water of 10-20 feet deep.

5. How to select a solar panel??

The best way to select the right components is to review the amount of water required per day. Based on the number of litres required per day, one can select the right water pump and then calculate the total power required that needs to be produced by the solar panels. The pump manufacturer will provide information on the number of watts that are required to produce the desired water flow. After selecting the size and type of the solar pump, the available information can be used to calculate the watts of the solar panels. To increase the pumping volume and time, the solar panels can be installed on tracking system. With the use of solar trackers the system output can increase by up to 30%.

6. Working principle:

When the solar energy drops sun rays on the PV panels then the solar panel converts the rays into electrical energy with the

help of Si wafers fixed within the PV panels. Then the solar energy supplies to the electrical motor to operate the pumping system using cables. By the revolution of the shaft which is fixed to the pump, then the pump begins to pick up the soil water and supplies to the fields

7. Calculation:

Suppose, our total daily water requirement =25 m^3/day
Total vertical lift=12m
So frictional losses = 5% of total vertical lift
=12*0.05=0.6 m
So total dynamic head=12+0.6=12.6 m
We know hydraulic energy required to raise water level= (mass*g*TDH=1000*25*9.81*12.6=857.5 Whr/day)
We assume solar radiation data=6 hr/day
Total wattage of PV panel=total hydraulic energy/no of hours of peak sunshine=857.5/6=142.9
Considering system losses=total PV panel wattage/(pump efficiency*mismatch factor)=142.9/(0.3*0.85)=560W
Considering operating factor=total PV panel wattage after losses/operating factor=560/0.75=747.3W
So solar PV panels required 75W each=747.3/75=9.96=10
Power rating of motor=747.3/746=1 HP

8. Specification and Pricing:

Table 1:

Particulars	Specification
Wind velocity withstanding capacity	150 km/h Suitable fastening and grounding shall be provided to secure the installations against the specific wind loads
Structure material	Pre galvanise sheet steel with a minimum galvanisation thickness of 80 microns
Bolts, nuts, panel mounting clamps	Stainless steel(SS) 304 for bolts, nuts and mid clamps
Concrete foundation	Concrete foundation made up of M20 grade of concrete, a minimum of 300*300*300(l*b*h)
Panel tilt angle	North-south orientation fixed tilt angle
Access for panel cleaning and maintenance	All solar panels must be accessible from the top for cleaning and from bottom for access to the module junction box

9. Quantity Specifications:

Table 2:

Serial Number	Item	Quantity	Unit
1	PURLIN	2	NO'S
2	RAFTER	2	NO'S
3	FRONT LEG	2	NO'S
4	BACK LEG	2	NO'S
5	BASE PLATE	4	NO'S
6	END CLAMP	4	NO'S
7	MID CLAMP	2	NO'S
8	DEGREE HOLDER	4	NO'S

10. Costing Analysis:

Table 1:

Description	Material	Quantity	Unitary Value	Total
suction	Curve of 90 degree	1	17	17
	Valve	1	30	30
	Register	1	218	218
	PVC tube	10	17	170
head	Curve of 90 degree	2	8	16
	Curve of 45 degree	2	5	10
	Register	1	85	85
	Retention valve	1	30	30
	PVC cube	100	11	1100
Solar energy	Solar panel(240 watt)	13	1800	23400
	Battery(120 A)	8	720	5760
	Inverter	1	1199	1199
	Load controller(60A)	1	1113	1113
	Electric motor +pump	1	696	696

11. Benefits to farmers:

- ✓ Potentially high initial system cost But it gives more benefit in long time.
- ✓ Low labour and maintenance costs.
- ✓ No fuel costs.
- ✓ Easy to remove, transport, and store.
- ✓ Produces water during sunny weather when it's needed most.
- ✓ Reliable and long life.
- ✓ Non-polluting.

12. Applications:

- ✓ Domestic portable water for remote homes.
- ✓ Pond water management and water transfer.
- ✓ Water supply for villages in developing world

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