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Solar Operated Pesticide Sprayer in Agriculture Field

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***Abstract*—Today's world energy demand is more then generation and therefore huge "energy crisis" probles are exist.. To meet the future "energy demands", the use of non-conventional energy as an alternate solution . In order to meet the food requirements of growing population, modernization of agriculture has become a necessity. In agriculture, spraying of pesticides is an important task to protect the crops from insects for obtaining high yield. However, farmers have been mainly using traditional conventional techniques like hand operated and fuel operated spray pump system for spraying pesticides.The Existing sprayer has the difficulties as follows,**

The conventional sprayer needs lot of effort to push the liver up and down in order to create the pressure to spray.

Another difficulty of petrol sprayer is to need to purchase the fuel which increases the running cost of the sprayer.

In order to overcome these difficulties Solar power sprayer has great importance in agiculture field because of elimination of engine fuel , vibrations and noise. The elimination of fuel will make our spraying system eco-friendly.

***Index Terms*— non-conventional energy; Solar power sprayer ; photovoltaic cell ,battery.**

I. INTRODUCTION

Renewable Energy resources are eco-friendly. Of all the renewable energy resources, solar power is available in abundent and free from pollution. The solar energy is usually harvested through solar panels that are made up of photovoltaic cells. Approximately 80% of all photovoltaic systems are mended into a standalone system.

The adventage of photovoltaic modules and arrays or simply solar panel corroborates this progress. The photovoltaic (PV) or solar cells crafted from silicon semiconductor are configured to trap and convert the sun's energy into the useful energy which is then used to perform work such as, irrigation pump, pesticide Duster etc.. Lot of research work has been carried out on the applications of solar energy for the irrigation pumps. From the comparison, it is concluded that solar energy is efficient.

II. PHOTOVOLTAIC CELL

A solar cell or photovoltaic cell is a wide area electronic device that converts solar energy into electricity by the photovoltaic effect. Photovoltaic is the field of technology and research related to the application of solar cells as solar energy. Sometimes the term solar cell is reserved for devices intended specifically to capture energy from sunlight, while the term photovoltaic cell is used when the source is unspecified. Assemblies of cells are used to make solar modules, or photovoltaic arrays.

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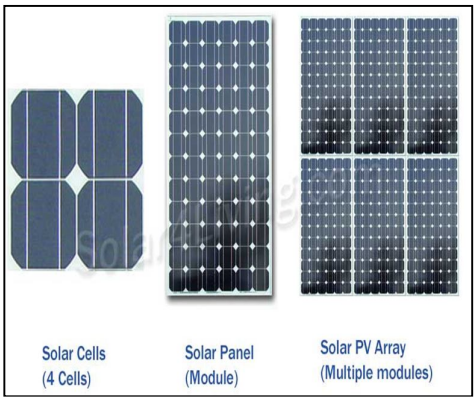

Figure 2.1: photo voltaic cell

A. Solar Panel

A solar panel is a device that collects and converts solar energy into electricity or heat. It transfers energy from the sun into electricity or heat which can be used by (for example) nearby buildings. Solar panels can be made so that the sun's energy excites the atoms a silicon layer between two protector panels. The atoms split up and the electrons travel down wires into the home for electricity. Solar panels were in use over one hundred years ago for hot water heating in homes. Solar panels can also be made with a specially shaped mirror that concentrates light onto a tube of oil. The oil then heats up, and travels through a vat of water, instantly boiling it. The steam created turns a turbine for power.

Photovoltaic panels, used to generate renewable electricity directly from sunlight Solar thermal energy collection systems, used to generate electricity through a system of mirrors and fluid-filled tubes Solar thermal collector, used to generate heat Solar hot water panel, used to heat water, often in homes and other private housing estates.

B. Water Diaphragm Pump

The diaphragm pump is used or pumping water. It is a positive reciprocating displacement pump. When the diaphragm is pulled back a vacuum is created in the chamber in front of the diaphragm. This vacuum causes the discharge valve to be forced against its seat. The vacuum allows atmospheric pressure to push the fluid up against the outside of the suction valve, opening the valve and filling the chamber. When the pressure is returned to the diaphragm forcing it towards the front of the chamber, the increased pressure causes the suction valve to be forced closed and discharge valve to be forced open. The fluid is push out of the chamber and the pumping cycle starts over.

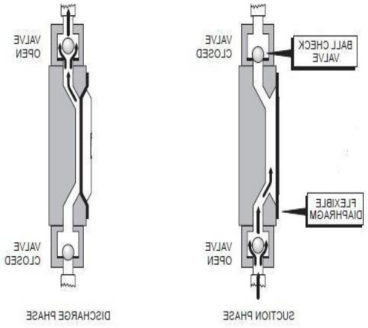

Figure 2.2: working of water diaphragm pump

C. Storage Battery

The lead acid battery uses the constant current constant voltage (CC/CV) charge method. A regulated current raises the terminal voltage until the upper charge voltage limit is reached, at which point the current drops due to saturation. The charge time is 12–16 hours and up to 36–48 hours for large stationary batteries. With

Figure 2.3: 12V lead acid battery

higher charge currents and multi-stage charge methods, the charge time can be reduced to 8–10 hours; however, without full topping charge. Lead acid is sluggish and cannot be charged as quickly as other battery systems.

Lead acid batteries should be charged in three stages, which are

[1] constant-current charge,

[2] Topping charge and

[3] Float charge.

The constant-current charge applies the bulk of the charge and takes up roughly half of the required charge time; the topping charge continues at a lower charge current and provides saturation, and the float charge compensates for the loss caused by self-discharge.During the constant-current charge, the battery charges to about 70 percent in 5–8 hours; the remaining 30 percent is filled with the slower topping charge that lasts another 7–10 hours. The topping charge is essential for the well-being of the battery and can be compared to a little rest after a good meal. If continually deprived, the battery will eventually lose the ability to accept a full charge and the performance will decrease due to sulfation. The float charge in third stage maintains the charge battery full.

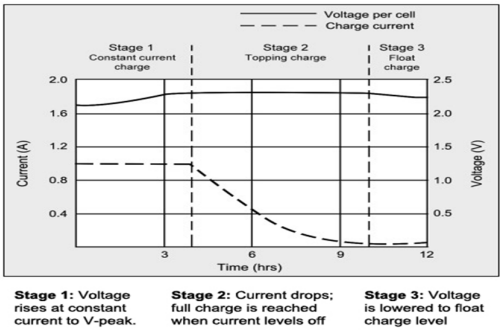

Figure 2.4: Charge stages of a lead acid battery

The battery is fully charged when the current drops to a set low level. The float voltage is reduced. Float charge compensates for self-discharge that all batteries exhibit.

The switch from Stage 1 to 2 occurs seamlessly and happens when the battery reaches the set voltage limit. The current begins to drop as the battery starts to saturate; full charge is reached when the current decreases to 3–5 percent of the Ah rating. A battery with high leakage may never attain this low saturation current, and a plateau timer takes over to end the charge.

The correct setting of the charge voltage limit is critical and ranges from 2.30V to 2.45V per cell. Setting the voltage threshold is a compromise and battery experts refer to this as “dancing on the head of a needle.” On one hand, the battery wants to be fully charged to get maximum capacity and avoid sulfation on the negative plate; on the other hand, over-saturation by not switching to float charge causes grid corrosion on the positive plate. This also leads to gassing and water-loss.

Advantages

Reliable.and Robust.

Tolerant to overcharging.

Low internal impedance.

Can deliver very high currents.
Indefinite shelf life if stored without electrolyte.
Can be left on trickle or float charge for prolonged periods.
Wide range of sizes and capacities available.
The world's most recycled product.

Figure 2.5: Battery charging adapter

D. External Charging Adapter

An AC adapter, AC/DC adapter, or AC/DC converter is a type of external power supply, often enclosed in a case similar to an AC plug. Other common names include plug pack, plug-in adapter, adapter block, domestic mains adapter, line power adapter, wall wart, power brick, and power adapter. Adapters for battery-powered equipment may be described as chargers or rechargers.AC adapters are used with electrical devices that require power but do not contain internal components to derive the required voltage and power from mains power. The internal circuitry of an external power supply is very similar to the design that would be used for a built-in or internal supply.
External power supplies are used both with equipment with no other source of power and with battery-powered equipment, where the supply, when plugged in, can sometimes charge the battery in addition to powering the equipment.
Use of an external power supply allows portability of equipment powered either by mains or battery without the added bulk of internal power components, and makes it unnecessary to produce equipment for use only with a specified power source; the same device can be powered from 120 VAC or 230 VAC mains, vehicle or aircraft battery by using a different adapter.

III. System Developmentand Component Specifications

The technical specifications for particulars, required to the sprayer are tabulated in table 1. The specifications considered are temporary and subjected to change depending upon the usability and complications of area and work undertaken.

A. Solar Panel Selection

The selection of solar panel is done by considering the weight criteria as well as its ability to charge the battery. The current produced by the solar panel was calculated by knowing the maximum power (P) of the solar panel and the voltage rating (V) of the battery. Charging time (T) was computed by the ratio of battery rating (Ah) to the total current produced by the solar panel.
From the Table II, it is observed that as the rating of solar panel increases its weight increases but the time for charging the battery decreases if the solar panel is operating at its maximum rating. Thus, by considering weight and charging time as the criteria, 20 watt rating solar panel was selected for our System.

C. Block Diagram

The block diagram of proposed system is as shown in figure 3.1. It consists of four units namely: energy conversion, storage, DC pump and sprayer. The details of each unit are discussed as follows.
The first unit of proposed system is energy conversion unit. The energy conversion can be done by two modes such as direct supply mode and solar energy mode. In case of direct supply mode, the single phase Alternating Current (A.C) supply was converted into Direct Current (D.C) supply with the help of full wave bridge rectifier chip (i.e. DB 107). This can be used, wherever the solar energy is not available i.e. during

TABLE I: TECHNICAL SPECIFICATIONS OF DIFFERENT COMPONENTS REQUIRED FOR MULTIPLE POWER SUPPLIED FERTILIZER SPRAYER SYSTEM

Sn	Particulars	Specifications
1	Solar Panel (Polycrystalline)	20W PV solar panel Dimension: 49×35×3 cm Weight :2 kg Max voltage : 17 V Max current : 1.18 A Open circuit volt: 21 V Short circuit current : 1.2 A Tolerance: ± 5%
2	Battery	Sealed Lead Acid battery Capacity:12V,.8Ah/20Hr Dimensions : 15×9×6 cm Weight : 2.5 kg Constant charge with voltage regulation Standby use : 13.5 - 13.8 V Cycle use: 14.5V – 14. 9 V Max initial current : 2.4 A
3	DC Diaphragı Pump	Dimensions: 17×6×6 cm Weight: 550 gm. Max discharge :3.1LPM Voltage:12V(Normally 9 to 14V) Current: 2.2 Amp Pressure:80PSI(5.5Bar)Cutoff
4	Charge controller	Input Voltage:2 20 V AC Capacity: 12V DC, Current:1A
5	Tank	PVC, 16 lit, 1 kg

TABLE II

Sr. No.	Solar panel rating (watts)	I =P/V (amp)	T = Ah/I (hrs.)	Weight (kg)
1.	6	6/12 = 0.5	9/0.5 =18	0.6
2.	8	8/12 = 0.67	9/0.67=13.5	0.8
3.	10	10/12 = 0.83	9/0.83= 10.8	1.2
4.	15	15/12 = 1.25	9/1.25 = 7.2	1.5
5.	20	20/12 = 1.67	9/1.67 = 5.3	2
6.	30	30/12 = 2.5	9/2.5 = 3.6	3.6
7.	40	40/12 = 3.33	9/3.33 = 2.7	5

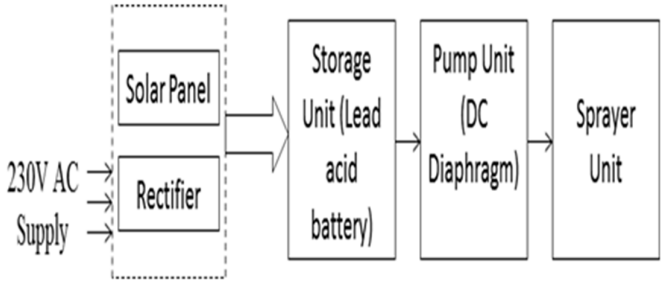

Figure 3.1: System Block Diagram

rain and cloudy weather conditions. In case of solar energy mode, solar energy obtained by the sun is converted into electrical energy using solar panel by photovoltaic effect.

The output of energy conversion was used to charge a deep cycle battery. The number of times a battery can be discharged is known as its life cycle. For solar applications, a battery should be capable of being

discharged in several times. In such cases a deep cycle battery is used. In this work a lead-acid accumulator serves the purpose. The lead-acid battery has the properties such as high current availability, contact voltage, longer life and more ability to charge as compare to conventional batteries.
The output of battery was connected to DC pump through switching circuit. In this work, DC pump is used because of the advantages such as less in noise, longer in life, maintenance free, motor speed can be varied in the larger extent by varying the supply voltage and self-lubricated. Pump is used to suck the spraying liquid from the sprayer tank and spray it through nozzle.
The sprayer consists of sprayer tank and sprayer pipe. The sprayer tank is made up of plastic or fibre material in order to reduce the weight of the tank. The capacity of the tank is 16 litters and connected to the sprayer pipe with adjustable nozzle. By adjusting the nozzle the output of flow can be controlled. The whole unit can be carried conveniently at the back of human body with the help of shoulder straps. The supporting base of entire unit needs to be strong and light weight.

IV. Solar Panel Fabricated Model & Performance Analysis

Solar panel can be locate in two ways a) Panel on top of sprayer b) Separate solar panel charging System .The solar agro sprayer consist of three main parts namely,

- Solar panel unit
- Storage battery unit and
- Rotating motor.

In the solar agro sprayer the two stroke petrol engine component of the power sprayer has been replaced with a combination of storage battery and DC pump. The action of the rotating motor could be controlled by a switch attached with it in the assembly. Solar panel arrangement has been provided at the top of the unit to charge the storage battery. The units of solar panel, storage battery and DC pump weremutually attached with one another. A solar panel of size of 49×35×3 cm area with an output power of 20 watt has been mounted on a rectangular metal frame which is enclosed over the cylindrical chemical tank of capacity of 16 litre. The solar panel arrangement was made at an angle of 35° to the vertical so that it should not create any trouble to the person who is loading the unit on his back. Moreover it is able to receive maximum solar radiationscontinuously from the sun during the operation of the unit in the field. The output of the panel is connected inparallel with the 12V storage battery to store the electrical energy from the solar panel. The 12V battery is properlyconnected with a 12 V DC pump attachment on the frame. The operation of the pump is controlled by a switch attached on the assembly. Energy received fromthe solar cell is stored in a storage battery unit forapplication. This stored electrical energy can be converted in to mechanical energy by pump. Forthis mechanical operation there is no need of conventional fuel like petrol and oil.
Working of this pump is simple. Solar panel collects the solar energy into electricity and supplies it to battery. Battery uses this electricity to charge itself. This battery next is used to operate pump. Pump attached at the bottom of tank sucks the liquid from tank and delivers it. The ‘ON’ and ‘OFF’ of motor is controlled with Switch attached to spray gun.

A. Solar panel Model

A switch is given there to operate its function. As the handle is pushed, the valve of gun is released and at the same timehe switch is pushed which supplies the current to pump. Thus motor sucks liquid and deliver it through delivery pipe.

A. Calculations

1) Analytical calculation of current and charging time of the battery:

a) The current produced by the solar panel (I) was calculated by knowing the maximum power (P) of the solar panel and the voltage rating (V) of the battery that is given by
I=P/V
Therefore,
I=20/12 = 1.66 Ampere

b) Charging time (T) was computed by taking the ratio rating of battery in ampere hour (Ah) to the total current consumed by the solar panel.
T= (battery rating in ampere hour)/(total current consumed by the solar panel)
Therefore,
T=12/1.66=7.22 hours

2) Practical measurement of current and charging time of the battery:

Experimentally the current produced by the solar panel can be measured by connecting an ammeter in series with supply. The charging time of the battery using solar panel has been measured by continuously charging battery and it is found that 8 hours.

B. Testing

The solar powered spray pump system was tested for the following purpose:

- The time required to charge the battery completely.
- How long the battery can operate while being chargedand discharged simultaneously.
- Characteristics of battery voltage and fluid discharge w.r.t. time.
- Time required to spray pesticides over 1 acre of land.

The system was tested on 28/03/2017. It was placed in sunlight from 10am -1pm to charge the battery completely from 10.55 V-13.56 V. The fluid discharge was collected in the 1 lit measuring mug. The time taken to collect it and the corresponding battery voltage was noted.

C. Results

The proposed system was tested with AC charging as well as solar charging. From the results it was found that the current and time required for charging the full battery capacity of 12V, 8Ah by practically is 8 hours. The fully charged battery approximately sprays4-5 acres of land. It was also found that, if we charge the battery in a day it can be used to spray 200 liters of fertilizer. The initial cost of the proposed system is little more as compared to conventional sprayer but the running cost of the system is very less. The developed system used for spraying the fertilizer, pesticides, fungicides and painting

D. Economic Analysis

The cost of the fuel increases day by day. It should be reduced by the modified model which works on the principle of solar energy. The operating cost of power sprayer for one hour operation is calculated and its value is compared with the operating cost of solar sprayer. Its seems that there is no need of operating cost but, the initial investment towards the charging unit is a onetime investment with a life period of Twenty years which is almost equal to the unit cost of the power sprayer with twist of petrol engine.

TABLE III. COST ESTIMATION

Sr. no.	Parameters	Ratings	Nos.	Cost in Rs.
01	Solar panel	20W	01	1800
02	Sprayer Unit	16 litre	01	600
03	DC Diaphragm pump	12V,2.2A	01	1800
04	Battery	12V, 8Ah	01	500
05	Charging Cord	12V,1A	01	400
06	Other	----------	------	2000
TOTAL COST				6,700/-

V. CONCLUSION

The solar powered agricultural pesticide sprayer has been fabricated according to the design parameters. The prototype was field tested according to the standard conditions. Our sprayer is of low cost and is easy to move in the field. After experimentation, it was observed that it reduces the user fatigue and improves the quality of spraying pesticides.

REFERENCES

[1] R. Joshua, V. Vasu and P. Vincent, Solar Sprayer -An Agriculture Implement, International Journal of Sustainable Agriculture.

[2] Solar photovoltaic for sustainable agriculture and rural development, by B. van Campen, D. Guidi and G. Best, Environment and Natural Resources Working Paper No. 2FAO, Rome

[3] G. D. Rai, 1996, ―Solar energy utilization‖, pp.434-479.

[4] Dr. R. K. Bansal, 2008, ―Fluid mechanics and hydraulic machines‖, pp.-530-536.

[5] Laukik Raut, Smit Jaiswal, Nitin Mohite, 2013, ―Design, development and fabrication of agricultural pesticidessprayer with weeder‖, International Journal of Applied Research &Studies (IJARS), pp.1- 8.

[6] Zoeb khan, 2014, ―Unique solar operated spray jet, International Organization of Scientific Research(IOSR)-Journal of Mechanical and Civil Engineering (JMCE), pp.1-4.

[7] Varikuti Vasantharao, Sharanakumar Mathapati, Dr.Basavaraj Amarapur, 2013, ―Multiple powered supplied fertilizer sprayer‖, International Journal of Scientific and Research Publications (IJSRP).pp.-1-5