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Solar Photovoltaic Pesticides Sprayer

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***Abstract*:-- Energy is the basic need of human being. We are interested to turn science into green science by using non-conventional sources of energy. Sun emits solar radiation, which can be converted into electricity with the help of solar panels. This generated electricity can be further utilized to perform mechanical work. Farmer is the heart of Indian Economy and our research gives support by making farmer friendly solar operated pesticide sprayer pump. A Solar Operated Pesticide Sprayer is a pump running on electricity generated by photovoltaic panels or the thermal energy available from collected sunlight as opposed to grid electricity or diesel run water pumps. The size of the PV-system is directly dependent on the size of the pump, the amount of water that is required and the solar radiation available. In agriculture, spraying of pesticides is an important task to protect the crops from insects for obtaining high yield. Hence the system can be easily operated and there is no need of additional labourers which increases the efficiency of farmers.**

***Index Terms*:— Solar operated, Pesticide Sprayer, PV system**

I. INTRODUCTION

A sprayer is a mechanical device used to spray the liquid like herbicides, pesticides, fungicides and fertilizers to the crops in order to avoid any pest. Sprayer provides optimum utilization of pesticides or any liquid with minimum efforts. Most of the increase in the area of irrigated land in the world has been through the increasing use of engine-driven pumps. However, the increasing price of oil-based fuel has reduced the margin to be gained by farmers from irrigation, since food prices have generally been prevented from rising in line with energy costs. If we are to decrease our dependence on imported oil, we have to find methods for energizing irrigation pumps that are independent of imported oil or centralized electricity. Renewable Energy resources are the most preferable resources for generation of electrical energy because of their economic and eco-friendly nature. Solar Power is the most convenient alternative as it is free, abundant and has no adverse impact on the environment. 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. About 70% of the sunlight gets reflected back into the space leaving only 30% of usable sunlight to meet up our energy demands.

The advent 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 Dehydration of Agriculture products, irrigation pump, pesticide Duster.

A. Importance of solar energy

Solar Energy is an inexhaustible source of energy and while humans have been utilizing this energy since time immemorial, only recently has there been any real breakthrough in the real world applications of this form of energy. Some of the advantages of Solar Energy and its related applications are as follows: -

- No Pollution
- Long lasting solar cells
- Renewable Source
- Low maintenance
- Easy Installation

Solar power technology is improving consistently from time to time and as our non-renewable sources continue to decline, it's important for the whole world to move towards renewable sources of energy.

B. Brief Introduction of Different Types of Conventional Pesticide Sprayer

a. Hand driven sprayer:

Hand driven pumps consist of a flexible diaphragm made of synthetic rubber connected to the pump handle by a crankshaft mechanism, a rigid diaphragm chamber and either flat or ball-type inlet and outlet valves. The outlet valve is connected to a pressure

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chamber, which in many hand driven pump sprayers has a variable pressure setting valve. These pumps typically operate between pressures of 1 and 3 bar (15-44 psi) and it is suitable for herbicide application where large droplets are required to minimize spray-drift.

b. Boom type pesticide sprayer:

This product is widely used in agriculture, farming, cleaning, cooling and other purpose. These products are precision engineered using finest quality raw materials to meet the requirements of clients for a long span of time without any trouble. This range of boom sprayer is offered in various technical specification and is high in demand due to its reliable functionality and durable finish standard.

II.DESIGN METHODOLOGY

PV systems need to be designed so as to satisfy the given load requirement. Once the system configuration is decided the capacity of the various components is decided. The choice between high quality expensive component or low quality cheap components lies in the hands of the designer. Along with these considerations other factors like size constraints and power saving must also be taken into account.

The design of PV systems can be categorized into two steps: -

- Approximate design.
- Precise design.

The overall design can be divided into six steps as given below:

- **Step 1**: Determine the PV system configuration.
- **Step 2**: Determine the power and torque required to cutting sugarcane.
- **Step3**: Selection of DC motors, by considering the output torque and power input.
- **Step 4**: Determination the size of solar PV module required, the motor rating taking in consideration
- **Step 5**: Selection of storage battery and charge controller circuit.
- **Step 6**: Development of the model.

Structural Block Diagram

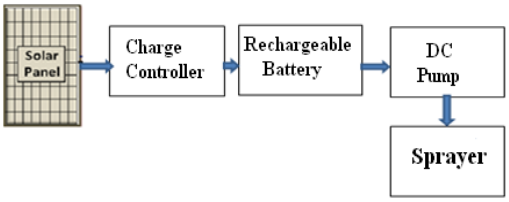

Fig.1.Block diagram

a Energy conversion:-

There are two modes of energy conversion.

- Direct supply mode
- Solar energy mode

In direct supply mode ac is converted to dc by full wave rectifier chip. In case of solar energy mode, the solar radiations obtained from the sun is converted to electrical energy using the PV cells present in the solar panel. The output of energy conversion is used to charge a deep cycle battery. The terminals of this battery are connected to the dc pump via a protection circuit. When operated, the pump sucks the spraying liquid from the sprayer tank and sprays it through the nozzle. The main advantage of this system is that it is maintenance free while the noise output is significantly lower than the fuel powered systems.

b. Sprayer: -

Sprayer consists of two major components namely – sprayer tank and sprayer pipe. The whole unit can be carried conveniently on the back of human body with help of shoulder traps.

B. Construction

- Tank: Capacity of the tank depends on the designer. Material like plastic is used to make the tank light and thus, portable.

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- Solar panel: Solar panel is a packaged assembly of PV cells accommodated together. Each panel is rated by its dc output power under standard test conditions and typically ranges from 100-320Watts.
- DC water pump**:**-Dc motor is used to lift the pesticide from the tank and deliver it to sprayer gun.
- DC battery**:**-Dc battery is the power source for the spray pump. It is charged by the solar panel and ac mains.
- Solar charge controller**:** - The sunlight controls the discharging or over charging of the battery.
- Nozzle:-It is the basic component of spray pump which generates spray pattern. The area it covers depends on the spray angle. Two main types of nozzles are –Full cone nozzle and Flat fan nozzle.

C. Working Principle and Operation: -

This project operates on solar energy. The setup is accomplished by the use of solar panel, a centrifugal pump which runs on dc supply is attached to the solar panel. The Solar panel generates the electricity with the help of PV cells that are arranged inside it. The generated electricity is stored in a battery which comes into play during periods of low sunlight. Once operated, the sprayer sucks in the pesticide solution from the tank and sprays it across the field. . There is no much maintenance cost and no operating cost as it is using solar energy it is free of cost and there is no pollution its working principal is very simple and it is economical of the farmers which has one more advantage that it can also generate power that is saved in the battery and it can be used for both for spraying and well as to light in the house when there is no current supply. Whereas in rainy season when the sun rays are not there that time we can charge the battery and use it to spray pesticides to the herbs and plants.

III.TESTING AND PERFORMANCE ANALYSIS

A. Analytical Calculation of Current and Charging Time of the Battery.

(i)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=5/12 = 0.42 Ampere

(ii). 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=7/0.42=16.67 hours

B. 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 17.5 hours for three days of every day 8 hours.

Table I Comparison Of Values Theoretical And Practical

Charging time of the battery		Current		Voltage		Discharging time
Theoretical	Practical	Theoretical	Practical	Theoretical	Practical	Practical
14.67 hours	17.20 hours	1.32 amps	1.06 amps	21 Volts	19.5 Volts	5.45 hours

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Table II. Comparison of solar sprayer conventional method

s/no	Particulars	Solar based	Conventional based	Petrol engine based
1	Cost	5300	4200	8500
2	Weight	18	9	15
3	Discharging time(minutes) For 15 liters tank	30	40	30
4	Running cost	Nil	Nil	Fuel cost
5	Maintenance cost (year/Rs)	Nil	Nil	300

Table III
Comparison of solar sprayer conventional method

Sl no	Voltage (Volts)	Current (Amps)	Speed (Rpm)	Power (Watts)	Torque (N-m)
1	9	0.33	2315	2.97	0.0123
2	10	0.4	2552	4	0.015
3	11	0.58	2843	6.38	0.0214
4	12	0.93	3091	11.16	0.0345
5	13	1.2	3639	15.6	0.0409

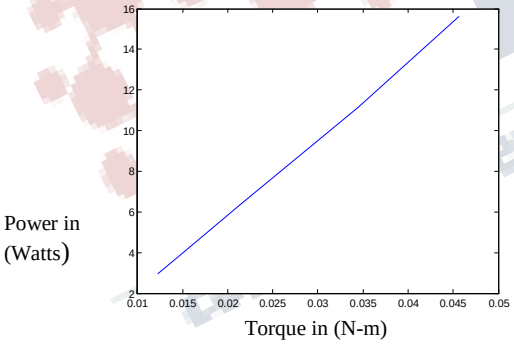

Fig 2. Torque V/S Power Characteristics

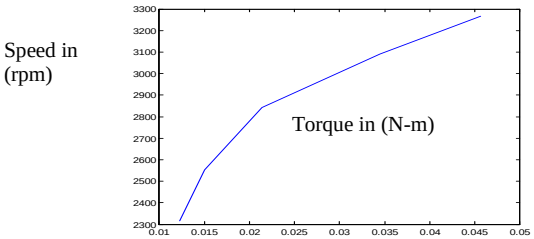

Fig 3. Torque V/S Speed Characteristics

IV. MERITS

- Eco Friendly
- Low operating Cost
- Effective Spraying
- Low Power Consumption
- Easy to Operate
- PV Cells have a long life span of around 30 years
- PV can operate even under cloudy condition

IV. 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 and it was found that the current and time required for charging the full battery capacity of 12V, 7Ah by analytically and practically is 14.67 hours and 15.2 hours respectively. The fully charged battery can be use to spray 620 litres of pesticides, which approximately spray 5-6 acres of land. After experimentation, it was observed that it reduces the user fatigue and improves the overall efficiency of the spraying operation. PV Cells generate DC Current. Special inverters are required to perform the conversion.

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