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Multiple Power Supplied Fertilizer Sprayer

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Abstract- In this paper, the design and implementation of multiple power supplied fertilizer sprayer has been presented. The proposed system is the modified model of the two stroke petrol engine powered sprayer which minimizes the difficulties of the existing power sprayer such as operating cost, changing of fuel etc. The two stroke petrol engine has been replaced by a direct current motor and operated by the electrical energy stored in the battery attached to the unit. The battery can be charged by solar panel during the presence of sun. It could also be operated on direct current during rainy and cloudy weather conditions. This system can be used for spraying pesticides, fungicides, fertilizers and paints.

The proposed system has been tested and compared with theoretical values of current and charging time. From the results it is found that the time taken to charge the full battery of capacity 12V, 7Ah has required 16.67 hours. The fully charged battery could be used to spray 575 liters pesticides. Which is approximately covers 5-6 acres of land. It is also found that, if we charge the battery for a day, then it covers approximately 200 liters of pesticides which in turn covers 2 to 2.5 acres of land. The developed systems initial cost is little more as compared to conventional sprayer but the running cost of the system is all most zero in other words minimum.

Index Terms- Solar Panel, DC Pump, Microcontroller, Sprayer, Fertilizer

I. Introduction

RENEWABLE Energy resources are the most preferable resources for generation of electrical energy because of environmentally friendly. Of all the renewable energy resources, solar power is the most resource mainly because it is free, unlimited and free from pollution [1]. 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 [2].

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 [3], irrigation pump[4][5][6][7][9], pesticide Duster[8] etc.

M.Y.Hussain and et al[3] have been developed a mixed mode solar dehydrator for dehydration of agriculture products. The agriculture products were included such as fruits and vegetables of common uses are dried under hygienic environment. They also claimed that the cost of dehydration is nominal and qualities of the dried products are up to the marketable standards. Lot of research work has been carried out the applications of solar energy for the irrigation pumps Sonali Goel and et al[4] have proposed a solar application for water pumping system and its comparison with the other non-conventional energy sources such as wind, micro hydro and biomass energy. From the comparison, they concluded that solar energy efficient. Mahir et al[5] [6] have proposed automatic drip irrigation of drawf cherty tree system with solar powered brushless D.C. motor. It is also shown that the efficiency of system increases by tracking. Hemant Ingale et al[7] have propsed an automatic solar based agriculture pumping using micro controller. This can be used for gardens, allotments, and greenhouses and polytonal. S.Mathana Krishnan [11] have proposed residential solar cooker system by introducing of phase charge materials used for harvesting of sun's energy to cook. By doing this, they have shown that efficiency of cooking increases. Abhishek Jivarg et al[8] have presented a paper on solar operated multiple granulated pesticide duster .In which solar energy used for pesticide duster.

The conventional sprayer having the difficulties such as it 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, we have proposed a Multiple Power supplied Fertilizer Sprayer. This can be operated using solar energy during the presence of sun, otherwise it can be operated using the electricity supply. The main advantages of the presented system are the running cost reduces to minimum and also time saving.

II. EXISTING SPRAYERS

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 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. *Fuel Operated Sprayer*

The power sprayer consists of an integrated or external spray tank; a high pressure piston pump usually powered by a petrol engine a pressure regulating valve and a hose of up to 50 m of length. Spray tanks are too big to be carried as a knapsack. The power sprayer is produced in a number of versions. Most simple and common is an engine driven pump mounted on a frame without wheels, a 200 l drum and hose and lance. Flow regulation is to be done via a pressure regulating valve and/or by restrictors (basic power sprayer) and the size of the nozzle. At the other end of sprayers mounted on wheels, equipped with pressure regulators. Technically, the power sprayer has a lot in common with the motorized knapsack-sprayer. The unit is generally set for high volume spraying, transporting the droplets with high pressure. Hallow cone nozzles are the preferred type of nozzles.

III. BLOCK DIAGRAM

The block diagram of proposed system is as shown in figure 1. It consists of five units namely: energy conversion, storage, protection & control, DC drive and sprayer. The details of each unit are discussed as follows

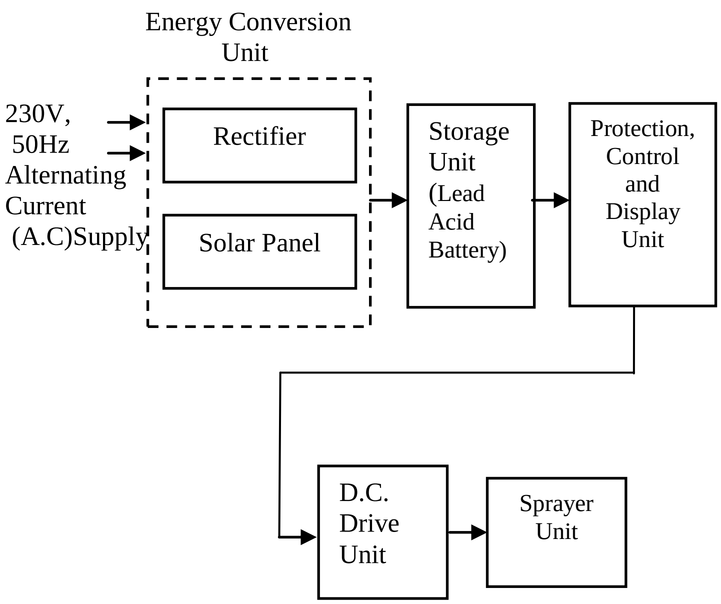


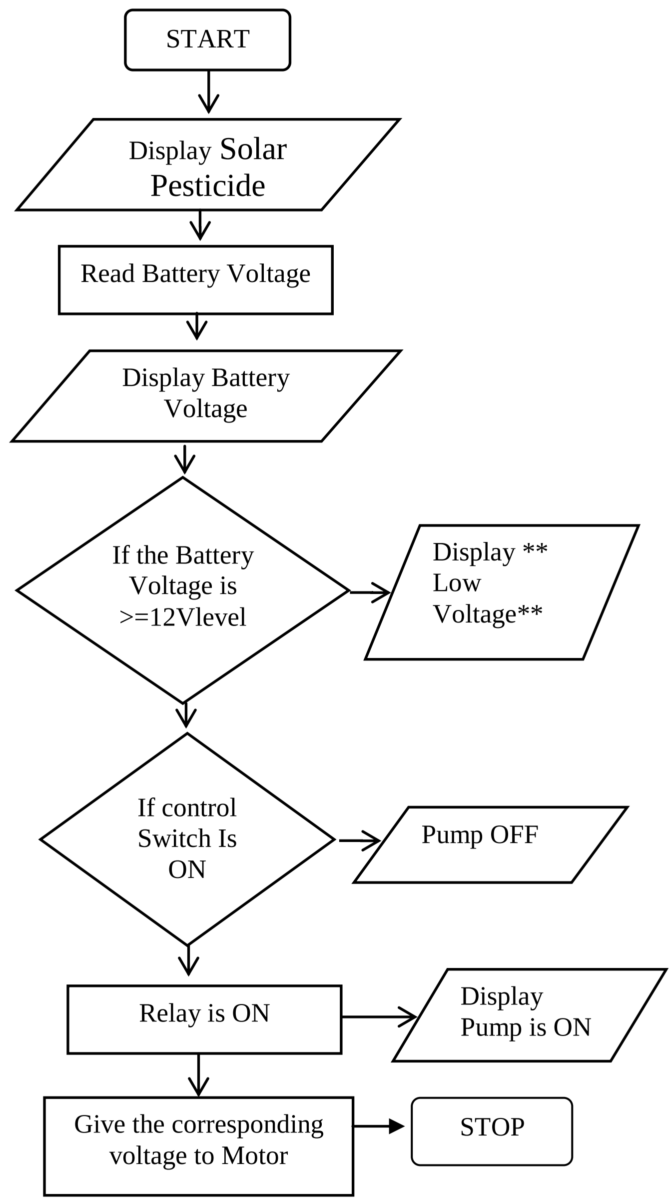
Figure 1: The block diagram of proposed system

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 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 protection 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 fiber material in order to reduce the weight of the tank. The capacity of the tank is 16 liters 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. SOFTWARE



Microcontroller starts when the power supply is given to it. In the first line of coding the microcontroller displays the title as “Solar Pesticide Sprayer”. If the output pin is high the microcontroller sends the signal to LED, LED starts blinking this shows health of the microcontroller, the LED blinks with the delay of 50ms. The voltage level in the battery is sampled with the use of inbuilt ADC the microcontroller displays the amount of voltage present in the battery on LCD display. In the next line of coding microcontroller checks whether the voltage level is equal to more than or 12V. If the condition is not satisfied i.e. if the battery voltage is less than 12V microcontroller display as **LOW VOLTAGE** on the LCD display. If the condition is satisfied the microcontroller checks the status of the control switch, if the control switch is pressed the relay goes to ON state, once the relay is ON the voltage from the battery is fed to DC pump and pump is ON. On the pump is ON the display unit displays as “Pump Status: ON”.. If the control switch is not pressed the display unit displays as “Pump Status: OFF”. In any stage of the execution if the RESET button is pressed the microcontroller starts the execution from the beginning.

V. WORKING

The working of the proposed system is as follows: when the control button is made ON and OFF while the sprayer motor is switched ON and OFF using the push button. The sprayer takes the energy from the energy conversion unit and this energy is stored in form of chemical energy in the battery which is then converted to electrical energy required to run the DC pump through protection and control unit. The protection and control unit as shown in figure 2

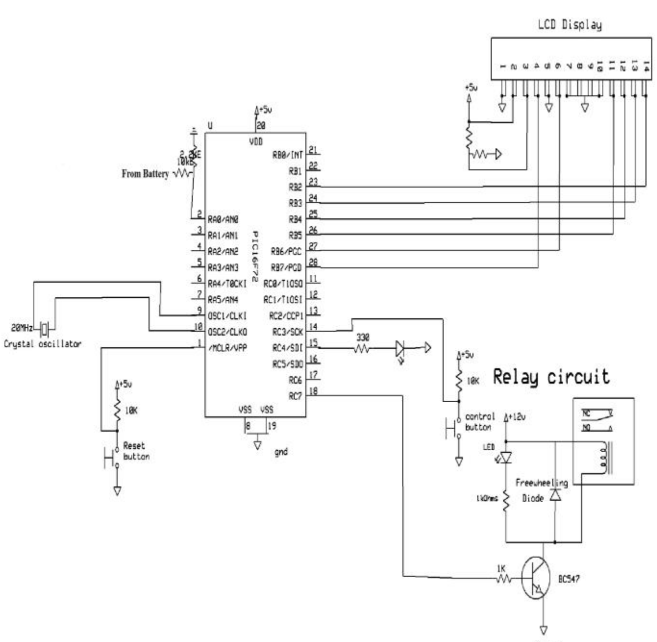


Figure 2: Protection and control unit

The protection and control unit consists of sampler, regulator and relay circuit. The sampler circuit samples the output voltage of the battery into voltage levels. The sampled voltage was converted into digital signal with the help of built in analog to digital converter of microcontroller PIC16F72. This digital value is compared with the set value of voltage level i.e. 12V. If the voltage level reaches less than set value then the relay operates in turn the pump made OFF. This circuit also protects from the over loading, internal fault condition. One of the ports of the microcontroller is connected to the LCD display, which continuously monitors and displays the voltage level of the battery and status of pump. The output of the control unit is connected to the pump. This is used for the sucking of liquid from the tank and sprays the fertilizer.

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.

Table 1: Technical specifications of different components required for multiple power supplied fertilizer sprayer system

S.NO	Particulars	Specifications
1	Solar Panel (Polycrystalline)	Max power, P_{max}: 5W Voltage at Max power, V_{mp}: 17.40V Current at Max power, I_{mp}: 0.29A Open circuit voltage, V_{oc}: 21.00V Short Circuit Current I_{sc}: 0.33A Tolerance: ±5% Max system voltage: 800V
2	Battery	Capacity: 12V, 7Ah Constant voltage charge with voltage

		regulation Standby use: 13.6V -13.8V Cycle use: 14.1V-14.4V Max initial current: 1.4A
3	Microcontroller	PIC16F72
4	DC pump	Voltage: 12V Current: 0.5 Amps to 1.5 Amp (max) Flow rate: >560ml / 10 seconds Fluid pressure: 1.6kgf/cm2

VI. DESIGN

1. 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

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 17.5 hours for three day of every day 8 hours.

The results obtained from the practical values and theoretical values were compared and they are tabulated in Table 2.

Table 2: Comparison of theoretical and practical values

Charging time of the battery		Current		Voltage		Discharge Time
Theoretical	Practical	Theoretical	Practical	Theoretical	Practical	Practical
16.67 hours	17.2 hours	0.42amp	0.25amp	21volts	19.5 volts	3.45 hours

The model of the designed fertilizer sprayer is shown in figure 3.

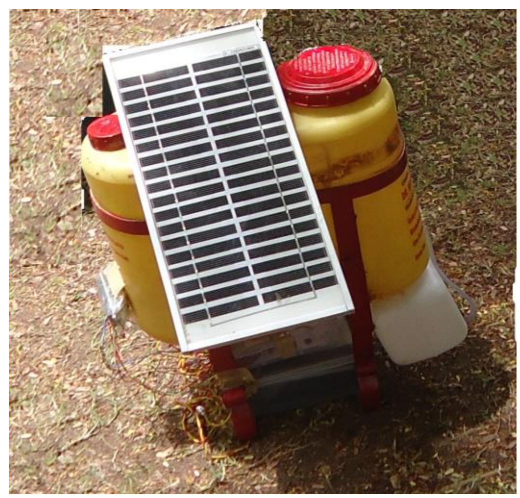


Figure 3: Working model of multiple power supplied fertilizer sprayer

VII. CONCLUSION

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, 7Ah by analytically and practically is 16.67hours and 17.2 hours respectively. The fully charged battery can be used to spray 580 liters of fertilizer, which approximately spray 5-6 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.

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