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Design and Fabrication of Hybrid Multipurpose Solar Sprayer.

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Abstract: **-- Energy demand is one of the major threads for our country. Finding solution to meet the energy demand is great challenge for Scientist, Engineers.Now a day pesticide sprayer is operated based on fuel engine. This operation is economical. In order to overcome this we found the new concept known as "Solar Pesticide Sprayer". In this pesticide sprayer is operated mainly based on solar energy and hence there is no need of any kind of alternative source. It has many advantages such as cost of spraying and also saving on Fuel/Petrol. There is less vibration as compared to the petrol sprayer. Hence the system can be easily operated there is no need of labors which increases the efficiency of farmers.**

Keywords: Solar panel, Diaphragm pump, Sprayer.

1. INTRODUCTION

Sprayer or Duster is equipment which is used for spraying insecticides, pesticides, and fungicides.An agriculture duster is a duster that has been built or converted for agricultural usually for aerial application of pesticides (crop dusting) or fertilizers.Dusters (sprayer) have become an indispensible for high productivity and have contributed to the worldwide crop production revolution.Dusters cover a wide variety of agricultural jobs and pest applications, including control of competing weeds and unwanted bushes and trees, control of diseases and insects, application of plant nutrients, and broadcasting of many crop's pesticide may be a chemical substance, biological agent(such as a virus or bacterium), antimicrobial, disinfectant or device used against any pest. Pests include insects, plant pathogens, weeds, molluscs, birds, mammals, fish, nematodes (roundworms), and microbes that destroy property, spread disease or are a vector for disease or cause a nuisance.

Conservation of non-renewable resources with an objective of attaining sustainable developments has lead to an incredible advancement in both understanding and employing sun's vast energy to benefit mankind.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 useful energy, which is then used to perform work. Hence, the optimum exploitation of sun's energy is used here to drive out a duster. The duster eliminates the conventional style of hand spraying powder pesticide, thereby reducing hazard of diseases and saves time. The Solar sprayer attempts to overcome the difficulties associated with existing models of sprayers, like hand sprayer, and reduce the human effort involved in it. It is modified version of a conventional sprayer which can be operated by the electrical energy stored in the 12V battery attached in the Unit. The 12V/ 7.2Amp battery can be charged by the Solar Panels. The electric motor operated by 12V/7.2Amp rechargeable battery, powers the pump which is connected to reservoir capacity of 20Liters. While spraying in the field the battery is charged by switching on the solar power system attached to the sprayer. During night the battery can be charged by means of alternate current (AC) supply.

II. LITERATURE REVIEW

India is a country of agriculture.Sprayers are commonly used on farms to spray pesticides, herbicides, fungicides, and defoliants as a means of crop quality control. There are many kinds of machine operated sprayers, the most common of which are low-pressure, high-pressure, air carrier, and fogger types. Though methods of chemical pest control have been used for centuries, they were not always spread by machine; before the 1800s, most

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pesticides were applied by hand. Early sprayers were most likely first developed to apply fungicides to the vineyards of Bordeaux, France. Between 1850 and 1860, John Bean of California, D.B. Smith of New York, and the Brandt Brothers of Minnesota developed the hand-operated insecticide sprayer. 1874 marked the year that knapsack sprayers first entered the U.S. market.

At the beginning of the following decade, the first commercial spraying machine was introduced. By 1887, the first spraying machine that did not rely on manpower was developed.This traction sprayer was supplied with power by the machine's wheels, and was horse-drawn. In 1894, the first steam-powered sprayer was produced.
Advancements continued, and by beginning of the 20th century, the first gasoline engine powered sprayer was on the market. As the chemical control market continued to develop, so did its machines. 1911 saw the introduction of a pressure regulator and air chamber; these were employed to achieve smooth, uninterrupted spraying. In 1914, Moses Rittenhouse began producing orchard sprayers for the fruit-producing region in Niagara, later founding M.K. Rittenhouse. Several years after the development of the row-crop tractor in 1925, tractor mounted sprayers were introduced. In 1944, dusting machines began to comprise attachments designed to inject water into the dust; this moisture supplied by this attachment enabled the dust to more effectively stick to dry leaves. The same year, low-volume, low-pressure sprayers were introduced. In 1945, 10,000 power sprayers were produced – this year marked the beginning of a decade-long span during which the use of sprayer dramatically increased. Two years later, 2, 4-D (Dichlorophenoxyacetic acid), a common herbicide used today, was first applied using low-pressure, low-volume sprayers to weeds in cornfields in selected southern states; the weed-control results were successful. In 1950, 75,000 power sprayers were produced.

2.1 Types Of Conventional Sprayers:
The five types of sprayers are as follows:
• Manual hand sprayers
• Backpack sprayers
• Boom sprayers
• Hydraulic handgun sprayers
• Air blast sprayers

B. Solar Technologies Produce Electricity:
The early development of solar technologies starting in the 1860's was driven by an expectation that coal would soon become scarce. However, development of solar technologies stagnated in the early 20th century in the face of the increasing availability, economy, and utility of coal and petroleum.
Between 1970 and 1983 photovoltaic installations grew rapidly, but falling oil prices in the early 1980's moderated the growth of PV from 1984 to 1996. Since 1997, PV development has accelerated due to supply issues with oil and natural gas, global warming concerns, and the improving economic position of PV relative to other energy technologies.

C. Solar/Photovoltaic Power:
Solar or photovoltaic (PV) cells are made of semiconducting materials that can convert sunlight directly into electricity. When sunlight strikes the cells, it dislodges and liberates electrons within the material which then move to produce a direct electrical current (DC).This is done without any moving parts. PV cells are combined to make modules that are encased in glass or clear plastic. Modules can be aggregated together to make an array that is sized to the specific application. Most commercial PV cells are made from silicon, and come in three general types: monocrystalline, multicrystalline, and amorphous.

D. Solar Cell:
The solar cell is the basic building block of solar photovoltaic. When charged by the sun, this basic unit generates a dc photo voltage of 0.5 to 1.0V and, in short circuit, a photocurrent of some tens of mA/cm2. Since the voltage is too small for most applications, to produce a useful voltage, the cells are connected in series into modules, typically containing about 28 to 36 cells in series to generate a dc output of 12 V.
To avoid the complete loss of power when one of the cells in the series fails, a blocking diode is integrated into the module. Modules within arrays are similarly protected to form a photovoltaic generator that is designed to generate power at a certain current and a voltage which is a multiple of 12 V.

III. METHODOLOGY

A. Working Principle Of Solar Sprayer:
• The "solar sprayer system", is a device used to spray the pesticide on the crops. The project involves converting a regular Hand Spraying Pump into an automatic Solar Powered spraying Pump.

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• The project includes designing, assembling, and testing of solar sprayer which is used to spray pesticides on the crops and also for other spraying purpose. The main component of the system is solar panel, battery, pump, container, hoses, and auxiliary switches etc.
• Solar radiation can be converted directly into electricity using semiconductor devices, which are known as Photovoltaic (PV) cells.
• The light energy is converted into electrical energy by solar PV cells a part of the light is absorbed and it is converted into Electrical Energy by means of Electron Movements and is stored into a lead acid battery (12V/7.2amp). The battery drives a pump (12V/2.2amp) by converting the electrical energy into mechanical energy. The pump is connected to the outlet pipe hose which in turn connected to nozzle.
• This pump draws the fluid (pesticide) from the reservoir and pushes it via nozzle at different rates.
• The nozzle in turn sprays it on to the field.
• The energy stored by battery can also be used for other purpose like lighting led bulbs and charging mobile phones and etc.

B. Constuction Details Of Sprayer:

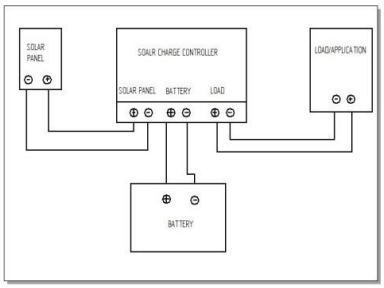

Fig-1 Line diagram of sprayer.

IV. GENERAL MACHINE SPECIFICATIONS

I. GENERAL MACHINE SPECIFICATIONS

❖ *Soalr Panel:*
Panel size = 50cm × 34cm
Weight = 1.7666 kg
Voltage = 12 volt
Current = 1.7 amp
Power = 12 × 1.7=20.4 watt

❖ *Pump:*
Pump Type = Diaphragm pump
Weight = 0.5 kg
Current = 2.2 amp
Voltage = 12 volt
Power = 26.4 watt

❖ *Battery:*
Weight = 2 kg
Voltage = 12 volt
Current = 7 amp hr
Cycle use = 14.1-14.4V
Standby use = 13.6-13.8V

❖ *Solar Charge Controller:*
Voltage = 12 volt
Current = 10 amps
Weight = 0.5 kg

V. RESULTS AND DISCUSSIONS

A. Experimentally Calculated Flow Rate:

Actual discharge of fluid from the sprayer is calculated by collecting the fluid for a particular time.Then the discharge is calculated by dividing time to the collected volume.

Assume height h=55m: pressure = $\rho \times g \times h$

$=1000 \times 9.81 \times 55$

$= 539.55 \times 10^3$ pa.

$\therefore$ we select 0.55 Mpa diaphragm pump.

Velocity,v = $(2 \times g \times h)^{0.5}=(2\times 9.81\times 55)^{0.5}=32.8497$m/s.

Discharge, Q = A × V: d = 1mm:

$= \{ (3.142/4) \times (1\times 10^{-3})^2 \times 32.8497\}\times 60000$

=1.5738 lpm.

Volume of Diaphragm pump:

$V=\prod \times h(D^2/8+h^2/6)$

$=\prod \times 4((0.04^2/8)+(0.004^2/6))$

$=2.5887\times 10^{-6}$ m^3.

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Table1: Experimentally Calculated Flow Rate.

Spraying Nozzle Type	Flow rate (LPM)	Time required to discharge 20 liter of fluid in minutes	Max discharge of fluid (liters) for full charge of battery	Spraying distance in meter
Without nozzle	2.4	7	410	0.3
Conical mist	1.1	18	125	1.8

B. Finite Element Analysis Of base Frame:

Finite element analysis is performed for stress ,strain behavior of the frame.
Material:- High density polyethylene(low grade)
Youngs Modulus:- 800 Mpa
Tensile Ultimate strength:-31.7 Mpa
Tensile yield strength:-26.6 Mpa
Density :- 970 kg mm^{-3}

C. Design Of Supporting Frame:

Total weight on base frame = panel weight+ weight of water + weight of tank with panel holder =1.777+20+3.734 =25.5 kg.
Force= 25.5 9.81= 250.155 N.
Frame is divided into two beams on each side and a column at centre.Therefore 83.385 N load is uniformly distributed over two fixed-fixed beams and a point load is concentrated over the column.

D. Directional Deformation:

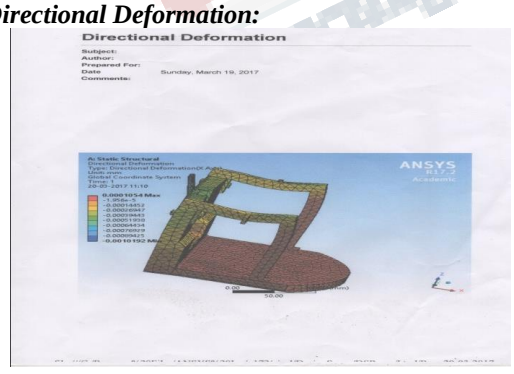

Fig-2 Directional deformation of base frame.

The above figure shows the analysis of base support in loaded condition. Maximum displacement is 0.0001054mm.

E. Equivalent Stress:

Fig-3 Equivalent stress of base frame.

The above figure shows the analysis of base support in loaded condition. Maximum Von Mises stress is 1.5343Mpa.

F. Diehard Battery Charger:

[(Amp hour rating * % of charge needed)/Amps] 1.25= Hours of charge time. Assuming 50% of charge is done.
Solar output voltage=17V.
Max power = 20 W.
Output current= Wp/(V 0.85)
=20/(17 0.85)
=1.3841 Amps.
Substituting the above values in battery charging calculation equation,
=[(7 0.50)/1.3841] 1.25
= 3.16 hours.

VI. CONCLUSION

By using the idea of solar power for a sprayer the study attempts to solve the problems associated with environmental pollution, fatigue on formers, operating of sprayers.

solar sprayers are of great advantage, because it is simple in construction with light weight. the device has minimum welded parts; this makes assembly, disassembly quite simple and makes the sprayer portable.

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the cost though appears a little higher, can be brought down greatly when produced in large scale. the model of proposed study has worked quite satisfactorily.

Advantages of solar sprayer over conventional sprayer:

- capacity of solar sprayer is 20 litre .i.e greater than convvetional sprayer.
- discharge in solar sprayer is constant when compared to conventional sprayer.
- power source is solar energy in solar sprayer.
- pressure is constant in solar sprayer where as pressure depends on human strength in conventional sprayer.
- fatigue is less i.e more in conventional sprayer.

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