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Solar Pesticide Sprayer

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Abstract *: 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 operation of solar powered pumps is more economical mainly due to the lower operation and maintenance costs and has less environmental impact than pumps powered by an internal combustion engine (ICE). Solar pumps are useful where grid electricity is unavailable and alternative sources (in particular wind) do not provide sufficient energy. The solar panels make up most (up to 80%) of the systems cost. The size of the PV-system is directly dependent on the size of the pump, the amount of water that is required (m³/d) and the solar irradiance available. The solar sprayer has many advantages. Besides reducing the cost of spraying, there is a saving on fuel/petrol. Also, the transportation cost for buying petrol is saved. The solar sprayer maintenance is simple. There is less vibration as compared to the petrol sprayer. The farmer can do the spraying operation by himself without engaging labour, thus increasing spraying efficiency*

Keywords: *Electricity, Photovoltaic cell, Solar Panel, Solar Pump, Sprayer.*

1. Introduction

Spraying of pesticides is an important task in agriculture for protecting the crops from insects. Farmers mainly use hand operated or fuel operated spray pump for this task. This conventional sprayer causes user fatigue due to excessive bulky and heavy construction. This motivated us to design and fabricate a model that is basically trolley based solar sprayer In our design, here we can eliminate the back mounting of sprayer ergonomically it is not good for farmers health point of view during spraying in this way here we can reduce the users fatigue level. There will be elimination of engine of fuel operated spray pump by which there will be reduction in vibrations and noise. The elimination of fuel will make our spraying system eco-friendly. So with this background, we are trying to design and construct a solar powered spray pump system.

Now days there are non-conventional energy sources are widely used. The energy which is available from the sun is in nature at free of cost. In India solar Energy is available around 8 months in year .so it can be used in spraying operation. Solar pesticide sprayer can give less tariff or price in effective spraying. Solar energy is absorbed by the solar panel which contains photovoltaic cells. The conversion of the solar energy into electrical energy is done by these cells. This converted energy utilizes to store the voltage in the DC battery and that battery further used for driving the spray pump.A sprayeris a device used to spray a liquid. In agriculture, a sprayer is a piece of equipment that is used to apply herbicides, pesticides, and fertilizers on agricultural crops. Sprayers range in size from man portable units (typically backpacks with spray guns) totrailed sprayers that are connected to a tractor, to self-propelled units similar to tractors, with boom mounts of 60–151 feet in length. Timely application of herbicides pesticides and fungicides at peak periods plays a vital role in ensuring better yields from a crop. The scope of the project is to develop a new mechanism for spraying of pesticides.

The mechanism is designed such that the potential energy of the pesticide stored in the tank and additional spring force is used for generating the required velocity during spraying so that to remove the pest and get a better yield. 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. Despite present short-term fluctuations in oil prices, conventional oil-based engine-driven power sources and mains electricity are expected to continue to increase in the longer term. 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. Solar radiation as a source of energy is Of course, the epitome of the clean. Sustainable energy technology except for residues possibly arising out of the manufacture of solar component (e.g semiconductors), solar technology have very low environmental impacts. The environmental impacts of solar system in operation are very low and the source is, for us inexhaustible.

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2. Literature Survey

AbhishekJivrag et al [1] describes invention and operation of multiple granulated pesticides duster with the use of solar energy. The concoction is accomplished by the use of solar panel, impeller type centrifugal blower, gear reduction mechanism, dispensers, D.C motors and batteries. In addition, the duster has been equipped with a facility to operate on an electric supply, which serves beneficial in the absence of sunlight. The device essentially works for disbursing solid granulated (powder) form of pesticide. The operator controls the rate and discharge of different pesticides by means of push buttons and toggle switches. The technical specifications of the device are worked and examined in a way to minimize the weight of the device and deplete the feeder unit dispenser in a span of three hours.

R.Joshua, V.Vasu et al [2] "Energy demand" is one of the major problems for our country. Finding solutions, to meet the "Energy demand" is the great challenge for Social Scientist, Engineers Entrepreneurs and Industrialist of our Country. According to them application non-conventional energy is the only alternate solution for conventional energy demand. Now-a- days the concept and technology employing this non-conventional energy became very popular for all kinds of development activities. Solar energy plays an important role in drying agriculture products and for irrigation purpose for pumping the well water in remote village without electricity.

B. van Campen, D et al[3] Solar photovoltaic (PV) systems have shown their potential in rural electrification projects around the world, especially concerning Solar Home Systems. With continuing price decreases of PV systems, other applications are becoming economically attractive and experience is gained with the use of PV in such areas as social and communal services, agriculture and other productive activities, which can have a significant impact on rural development. There is still a lack of information, however, on the potential and limitations of such PV applications. The main aim of this study is, therefore, to contribute to a better understanding of the potential impact and of the limitations of PV systems on sustainable agriculture and rural development (SARD), especially concerning income-generating activities.

R. Rajeshet al [4]. 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 more 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. Solar based pesticide sprayer is one of the improved model of pesticide sprayer pumps. Sun is the source of all energy on the earth. It is most abundant, inexhaustible and universal source of energy. All other sources of energy draw their strength from the sun. India is blessed with plenty of solar energy because most parts of the country receive bright sunshine throughout the year except a brief monsoon period

J. V. Bhanutej et al [5]. In India, agriculture has a predominant role in our day to day life. The crops that come as yield decides the total production, adds to the economy of our country. The yield decreases due to the presence of pests, insects in the farms. To kill the pests, insect's pesticides, fertilizers are sprayed either manually or by using sprayers. Earlier, the pesticides and fertilizers were sprinkled manually, but they will result in harmful effects on farmers. In order to overcome this problem, Different spraying techniques have been developed. These sprayers consist of different mechanisms and the cost of equipment is generally high. We developed a mechanism in which we tried to minimize the equipment cost by removing the pump to spray. This Sprayer works on Bernoulli's principle, in which the spraying action of the sprayer is due to the head developed and mechanical linkage. The model is developed mathematically for the major components like tank, required head and the spring mechanism

3. Working principle and fabrication details

This works on solar energy. The concoction 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 power that power is dc power its positive and negative charges are connected to a batter in order to save the power and use it when the sun raise are not present by using this device we can spray pest ices to the herbs and plants and any agriculture spraying it is economical as compared to the other means used like petrol/diesel pesticides sprayers. 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 the it is economical of the farmers which has one more advantage that it can also generate power that power 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. And where as in rainy season when the sun rays are not there

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that time we can charge the battery and use it to spray pesticides to the herbs and plants as compared to petrol/ diesel

it is economical no efforts to human just he has to carry the device the device is light in weight so it is much feasible.

The main components used to fabricate the model are:

- Solar panel
- Pump
- DC motor
- Battery
- Tank
- Nozzle
- Bevel gear

3.1 Solar panel

A solar panel(also solar module, photovoltaic module or photovoltaic panel) is a packaged, connected assembly of photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each panel is rated by its DC output power under standard test conditions, and typically ranges from 100 to 320 watts. The efficiency of a panel determines the area of a panel given the same rated output - an 8% efficient 230 watt panel will have twice the area of a 16% efficient 230 watt panel. Because a single solar panel can produce only a limited amount of power, most installations contain multiple panels. A photovoltaic system typically includes an array of solar panels, an inverter, and sometimes a battery and or solar tracker and interconnection wiring.

3.2 Pump

For people living in remote areas, solar water pumps are usually the only solution as there is no access to diesel. If there is diesel, Solar Water Pumps are the only solution or an excellent alternative for diesel as the cost of running power lines or diesel pumping may be too great. A solar powered water pump differs from a regular water pump only in that it uses the sun's energy to supply electricity for the pump. The solar panels absorb the sun's energy and convert it to electrical energy for the pump to operate. All the pumped water is stored in a water tank so that there is constant supply even in bad weather conditions and during night time where there is insufficient power to generate the solar water pumps. Solar powered water pumps represent a higher initial investment, however, over a period of 5 years they represent a cost benefit due to minimal maintenance costs compared to AC pumps run with a generator.

3.3 DC motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills.

3.4 Battery

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smart phones, and electric cars.When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. When a battery is connected to an external circuit, electrolytes are able to move as ions within, allowing the chemical reactions to be completed at the separate terminals and so deliver energy to the external circuit. It is the movement of those ions within the battery which allows current to flow out of the battery to perform work.

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3.5 Tank

Storage tanks are containers that hold liquids, compressed gases or mediums used for the short or long-term storage of fluids or gases. The term can be used for reservoirs. Storage tanks are available in many shapes: vertical and horizontal cylindrical open top and closed top flat bottom, cone bottom, slope bottom and dish bottom. Large tanks tend to be vertical cylindrical, or to have rounded corners transition from vertical side wall to bottom profile, to easier withstand hydraulic hydrostatically induced pressure of contained liquid. Most containertanks for handling liquids during transportation are designed to handle varying degrees of pressure.

3.6 Nozzle

A nozzle is a device designed to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe. A nozzle is often a pipe or tube of varying cross sectional area and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. In a nozzle, the velocity of fluid increases at the expense of its pressure energy.

3.7 Bevel gear

Bevel gears are gears where the axes of the two shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. Bevel gears are most often mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well. The pitch surface of bevel gears is a cone. Two important concepts in gearing are pitch surface and pitch angle. The pitch surface of a gear is the imaginary toothless surface that you would have by averaging out the peaks and valleys of the individual teeth. The pitch surface of an ordinary gear is the shape of a cylinder. The pitch angle of a gear is the angle between the face of the pitch surface and the axis.

The most familiar kinds of bevel gears have pitch angles of less than 90 degrees and therefore are cone-shaped. This type of bevel gear is called external because the gear teeth point outward. The pitch surfaces of meshed external bevel gears are coaxial with the gear shafts the apexes of the two surfaces are at the point of intersection of the shaft axes. Bevel gears that have pitch angles of greater than ninety degrees have teeth that point inward and are called internal bevel gears

4. Design calculation and specification

4.1 Selection of solar panel

Voltage at maximum power V =17.50V
Current at maximum power I=0.28A
We know the equation of power calculation,
Power: P= V x I
= 17.50 x 0.28 = 4.9 W
Power generated by solar panel= 5 watts
Battery12V, 7Ah current
Power = V x I
Power = 12x7
= 84Wh
Time required charging the battery

$$= \frac{84}{5}$$

= 16.8 hrs.
Note-Time varies because of intensity of sun radiations at different days.
Voltage = 12 V
Current = 1.5 Amp
We know the equation of the backup battery time of sprayer,
= (Power stored in battery / Power Consumed by motor (pump))

$$= \frac{84}{1.5 \times 12}$$

= 4.67hrs
Therefore the battery time spray = 4.67 hrs.

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4.2 Design of bevel gear

The primary considerations for designing the gear drive used were those of space and availability. Thus we have adopted the reverse engineering approach i.e we first purchased the gears and using the parameters known to us we calculated the safe load.

Power of motor P = 18W

Pressure angle, α = 20 deg full depth involute.

Number of teeth on pinion, Z_1 = 10 teeth.

Number of teeth on gear, Z_2 = 18 teeth.

Speed of the pinion, n_2 = 100 rpm.

Module, m = 5 mm.

Gear and pinion are made of cast steel C-20 (heat treated material).

Transmission ratio:$i=\frac{Z_2}{Z_1}=\frac{18}{10}=1.8$ (1)

Diameter of pinion, $d_1 = m \times Z_1 = 5 \times 10 = 50$mm.

Diameter of gear, $d_2 = m \times Z_2 = 5 \times 18 = 90$mm.

$\tan\delta_1=\frac{1}{i}$ (2)

Pitch angle of bevel pinion: $\delta_1 = \tan^{-1}[\frac{1}{1.8}]$

$=29.05^0$

$\tan\delta_2 = i$

Pitch angle of bevel gear: $\delta_2 = 60.95^0$

Virtual number of teeth on pinion: $Z_{vp}=\frac{Z1}{\cos\delta 1}=\frac{10}{\cos(29.05)}=11.44$ teeth (3)

Virtual number of teeth on gear: $Z_{vg}=\frac{Z2}{\cos\delta 2}=\frac{18}{\cos(60.95)}=37.07$ teeth (4)

Lewis form factor on pinion: $y_p=0.154-\frac{\mathbf{0.912}}{\boldsymbol{Z_{vp}}}$ (5)

$=0.154-\frac{0.912}{11.44}$

$=0.0742$

Lewis form factor on gear: $y_g=0.154-\frac{0.912}{Zvg}$

$=0.154-\frac{0.912}{37.07}$

$=0.129$

Gear and Pinion is made of cast steel C-20 heat treated, $\sigma_d = 191.295$mpa

$\sigma_d y_p = 14.194$

$\sigma_d y_g = 24.7535$

Pinion is weaker so, the further design is based on pinion.

Modified lewis form factor on pinion: $Y = y_p \times \pi$ (6)

$=44.591$m

Mean linear velocity:$v_m = \frac{\pi \times m \times ZP \times np}{60000}$ (7)

$=\frac{\pi \times 5 \times 10 \times 180}{60000}$

$= 0.4712$ m/sec

Service factor, C_s

Consider the shock to be steady shock and type of service as 3hr/day, $C_s=0.8$

Torque transimitted: $M_{t1}=\frac{9550 \times P}{n_1}$ (8)

$=\frac{(9550 \times 18)}{180}=955$ N-mm

Radius of pinion: $R=(\frac{m}{2}) \times \sqrt{((Z_1 \times Z_1)+(Z_2 \times Z_2))}$ (9)

$=(\frac{5}{2}) \times \sqrt{((10\times10)+(18\times18))}$

$=51.478$mm

Let Face width: $b=R/3 \Rightarrow 17.16\text{mm} \approx 18\text{mm}$

Velocity factor: $C_v=\frac{5.5}{5.5+V_m}$ (10)

$=0.92113$

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Mean linear velocity: V_m=0.4712 m/sec
Error: f = 0.0912
Constant: c = 600.4

Dynamic load: $f_d = \frac{f_t+((21vm \times (f_t+bc))}{21vm+\sqrt{(f_t+bc)})]}$ (11)

$$= \frac{36.077+((21\times 0.4712\times (36.077+(18\times 600.4))}{(21\times 0.4712+\sqrt{(36.077+(600.4\times 18)}\ )]}$$

=977N

Brinhell hardness number:BHN=450,
Load stress factor: K=3.9662MPa
Interference factor: Q =$\frac{2Z_2}{Z_1+Z_2}$(12)
=1.285
Wear load: f_w= $50\times 18\times 1.285\times 3.9662$
=4586.91N

$\frac{\text{Wear load}}{\text{Dynamic load}} = \frac{fw}{fd}$ =4.69 [∴ design is safe]

5. Assembly process

In the assembly process the base structure is made from cast iron and the required parts are fixed in the predetermined positions and the connections are made. Solar panel is placed in such a way that it can absorb the sunlight and this solar panel is connected to the controller and to the battery so that we can charge the battery and from battery is connected to the dc motor and with the help of the dc motor the pump is working and converting the mechanical energy to hydraulic energy and this energy pulls the pesticides which is mixed with water and through the piping it comes out of nozzle and pesticide is applied this is the assembly process. The Fig.1and Fig.2 shows the assembled model of proposed system.

Fig. 1the side view of assembled model

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Fig. 2the top view of assembled model

5.1 Results and Analysis

After analysis of the result after completing the solar powered pesticide sprayer, the discharge rate of pesticides from the tank is high and by this farmers can save time for spraying pesticides and since it is having wheels is very much easy to move it. It use solar energy which is renewable source of energy so there will be no pollution and it saves energy for future generation.Since India is an agricultural country so we need a pesticide sprayer witch works on solar energy witch does not cause any pollution and gives high output that saves money, time for farming.When we compared with the existing system we got that the system that we are using provides the required operation in less time and in large quantity without failure.

6. Advantages, Disadvantages, Applications and Future scope

The advantages, disadvantages, applications and future scope of this proposed model are:

6.1 Advantages

The advantages are as follows:

- Solar-powered pesticide Systems are practical in flat terrain where the sun shines.
- Solar-powered pesticide pumps can be placed in or next to the pond or other source of pesticide and the pesticide can be pumped where it is needed.
- Solar pesticide pumping is clean and efficient.
- Solar electric water pumping cuts down on waste because it's based on natural cycles. Your panels give the most pumping power on the sunniest days---when you need the most pesticide.
- Solar power is clean. You never have to worry about polluting
- Solar-powered pesticide systems take very little maintenance because they only have a few moving parts. They have long life---usually 20 to 40 years. And solar pesticide systems never run out of fuel as long as the sun is shining.

6.2 Disadvantages

The disadvantages are as follows:

- Relatively high initial cost.
- Lower output in cloudy weather.

6.3 Applications

The application of solar powered pesticide sprayer are:

- Mainly used in agriculture sectors for spraying chemicals on plants.
- It is also used in automobile industry for spraying paint.

6.4 Future Scope

Now we fabricating this model availability of components and economical and technology in future we will make according to that time technology if all the farmer use we can save the power

Conclusion

The method used here to build solar powered pesticide pumping system is cost effective comparatively to an electrically operated hydraulic pump. Since here non-conventional energy is used to achieve the required head. Discharge obtained from the observations is .5liters per minute. The reciprocating pump built by us is built with the help of simple and easily available materials still we have successful to demonstrate the worth of a reciprocating pump. This device serves its purpose to some extent, but with proper course of actions, it can perform still better

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