International Journal For Technological Research In Engineering
Volume 6, Issue 4, December-2018 *ISSN (Online): 2347 - 4718*

DESIGN AND DEVELOPMENT OF SPRAY SPRINKLING MECHANISM FOR AGRICULTURE USE

Ronak R. Suthar
Mechanical Engineering Department, K. J. Institute Of Engineering & Technology, Savli, Vadodara, Gujarat, India

ABSTRACT: The basic aim of rotary pesticide sprayer is to reduce the work of farmers which is done manually. Rotary pesticide sprayer is proved to be a useful machine which concentrates on ergonomics which is more efficient to workers, and the energy source used is non conventional. This will go to be more useful for eco smart farming. In the commonly available ones, the user needs to exert a lot of effort to push the lever up and down to create the pressure to spray.

Key Words: Agricultural Sprayer, Solar Energy, Crack Slotted Mechanism

I. INTRODUCTION

The basic aim of an solar pesticide sprayer is to reduce the work of farmers which is done manually. Solar Pesticide Sprayer is a useful machine which is ergonomics, motion sensible which is more efficient to workers, and the energy source used in non conventional. Hence it possess a great scope in future. Solar pesticide sprayer which consist of an solar panel ,a battery ,motor pump and a tank have the simplest assembly is going to be a very important tool of an eco smart farm which would encourage to further works related with for the farmers farms field and agriculture. The project working with fully solar-hydraulic technology the project working with technology limitation solved because our project powerful speedily process. The project has both project interfaces.

1. Solar
2. Hydraulic

It can be used as completely automatic system by using microprocessor and PLC circuit and reduce the human effort and easily controlled the operation.

Main Objectives are:

- Design project which works on Solar
- Easy to controlling
- Higher efficiency
- Automatically cover all area
- Works at very high pressure
- System is compact

WORKING PRINCIPLE:-

The basic block diagram of the solar based pesticide sprayer is as shown in the figure. It consists of solar panel, DC pump, battery charging kit, pesticide tank, spray nozzles, etc.

It uses solar energy to operate. First the solar energy is absorbed by the solar panel. This solar energy is then converted into electrical energy by the photovoltaic cell. Here buck and boost converter is used to supply a required voltage from solar panel to the battery. This process repeats continuously as we use the sprayer. To spray the pesticides a 12v, 2.1amp DC pump is required. DC pump is driven by the 12v 7AH battery. Pump consists of one inlet & one outlet. Inlet opening is connected to pesticide tank and outlet is connected by the sprayer nozzle. Pump creates the suction & helps to spray the pesticides to the crops, Pesticide tank is having capacity of 15 litre. Different types of nozzles are used for different kind of spray for example F nozzle, taper nozzle, sector nozzle.

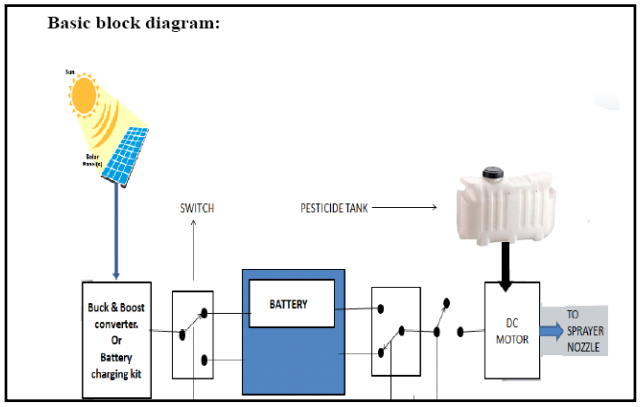


Fig1.2
Block Diagram

One can attach nozzle at the end of slotted lever. So as a result nozzle will oscillate around the crank and it will cover maximum area.

COMPONENTS:

The components of the project which are required to design are listed below, they are…

1 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 brushed 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. The advent of power electronics has made replacement of DC motors with AC motors possible in many

applications.

2 SHAFT

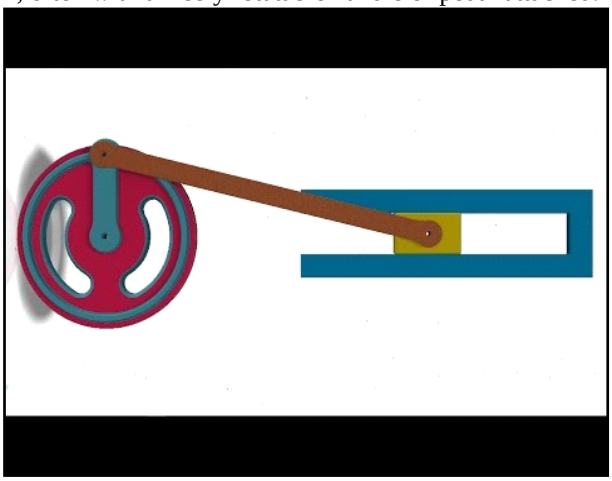
An axle is a central shaft for a rotating wheel or gear. On wheeled vehicles, the axle may be fixed to the wheels, rotating with them, or fixed to the vehicle, with the wheels rotating around the axle. In the former case, bearings or bushings are provided at the mounting points where the axle is supported.

SHAFT

In the latter case, a bearing or bushing sits inside a central hole in the wheel to allow the wheel or gear to rotate around the axle. Sometimes, especially on bicycles, the latter type axle is referred to as a spindle.

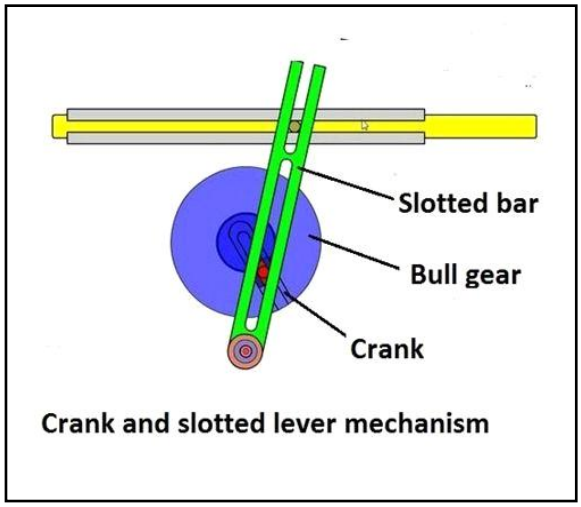
3 CRANK:-

A crank is an arm attached at a right angle to a rotating shaft by which reciprocating motion is imparted to or received from the shaft. It is used to convert circular motion into reciprocating motion, or vice versa. The arm may be a bent portion of the shaft, or a separate arm or disk attached to it. Attached to the end of the crank by a pivot is a rod, usually called a connecting rod. The end of the rod attached to the crank moves in a circular motion, while the other end is usually constrained to move in a linear sliding motion. The term often refers to a human-powered crank which is used to manually turn an axle, as in a bicycle crank set or a brace and bit drill. In this case a person's arm or leg serves as the connecting rod, applying reciprocating force to the crank. There is usually a bar perpendicular to the other end of the arm, often with a freely rotatable handle or pedal attached.



4 SLOTTED LEVER:-

A quick return mechanism is an apparatus to produce a reciprocating motion in which the time taken for travel in one direction is less than in the other. It is driven by a circular motion source and uses a system of links and sliding joints.



The disc influences the force of the arm, which makes up the frame of reference of the quick return mechanism. The frame continues to an attached rod, which is connected to the circular disc. Powered by a motor, the disc rotates and the arm follows in the same direction (linear and left-to-right, typically) but at a different speed. When the disc nears a full revolution, the arm reaches its furthest position and returns to its initial position at a quicker rate, hence its name. Throughout the cut, the arm has a constant velocity. Upon returning to its initial position after reaching its maximum horizontal displacement, the arm reaches its highest velocity. Quick return is a common feature of tools in which the action is performed in only one direction of the stroke, such as shapers and powered saws, because it allows less time to be spent on returning the tool to its initial position.

5 BATTERY

Fig 4 Battery

A battery converts chemical energy into electrical energy by a chemical reaction. Usually the chemicals are kept inside the battery. In order to choose the most convenient 12V battery. The characteristics that were taken into consideration in this decision were: price, amp hours, size, weight and

energy density.

It is used in a circuit to power other components. A battery produces direct current (DC) electricity. Using the electricity from an outlet in a house or building is cheaper and uses less energy, but a battery can provide electricity in areas that do not have electric power distribution. It is also useful for things that move, such as electric vehicles and mobile phones. Increased values of for the power draw were used to compensate for undesirable conditions.

6 DC WATER PUMP

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.

Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps.

Fig 5
DC Pump

Advantages of D.C. Motor Pump:-

- Easy to install.
- Runs dry without system.
- Massive 100PSI high pressure.
- Totally sealed, high stable pressure.
- Self priming, silent running, low power consumption.
- Easy connecting system.
- Motor duty cycle will vary with load and ambient temperature.

7 STORAGE TANK:-

A tank is a one type of device where one can store the liquid. In our module; The pesticide is stores into tank. The submersible pump is also fitted into the tank. The tank capacity in our module is approximate about 5 liters. The tank is located on the back side of the farmer. The nozzle is attach with the tank. The solar panel is also situate on the storage tank

Fig 6
Storage Tank

8 NOZZLE:-

It is a device which spray the liquid with high compressed ability & pressure. Due to this, the liquid surface area is increase. So, one can cover the more surface area.

Fig 7: Spraying Nozzle

Basically, nozzle is atomized the liquid. In our module; The nozzle is used for spray the pesticide. with the help of the pump, pesticide is comes into a nozzle from the tank. Now, nozzle can pressurized the pesticide & thrown by the outlet of nozzle. one can increase or decrease the flow of pesticide with the help of valve which is fitted on to the nozzle.

The main functions of a nozzle are:

- Metering (measuring) the amount of spray delivered (nozzle output) *f*
- Atomizing (breaking up) liquid into droplets *f*
- Dispersing (scattering) droplets in a given pattern

The spraying of pesticide is depend on the nozzle. There are different types of nozzle to get different types of flow of pesticide.
Most commonly nozzles which is used is given below.

- Flat fan nozzles
- Bomless nozzles
- Full and Hollow cone nozzles

9 Spray Angle:-
Nozzle spray angle is the angle formed by a single nozzle at a given pressure. Spray angle varies with pressure.
Nozzles can be purchased in a number of standard spray angles. The angle specified by the manufacturer is only obtained when pressure is in the recommended range.
The most common flat fan nozzle angles are 650, 800 and 1100. For a given nozzle type, wider angles decrease droplet size. This assumes that pressure and nozzle output remain constant.
Wider nozzle angles may give an even application with lower boom heights. Proper boom height depends on the spray angle Application Technology nozzle spacing.
10 PRESUURE REGULATING VALVE:-
It is a device which can regulate the flow of fluid. and also its acting like a key(ON/OFF). one can regulate the pressure & also regulating the flow of fluid.

Fig 8: Pressure Regulating Valve

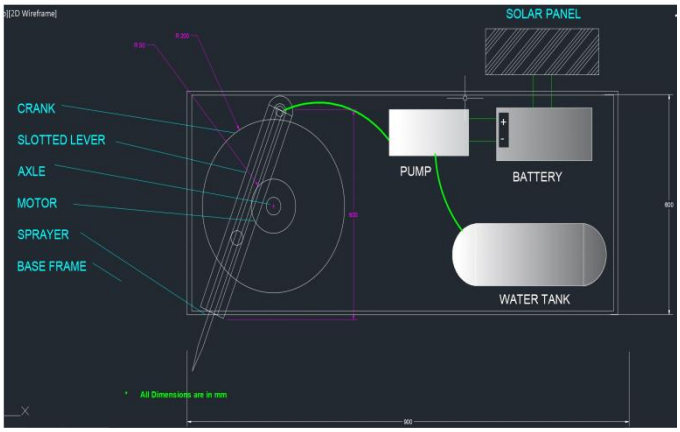
In our module, one can use the valve for regulate the pressure & also control the flow & pressure of pesticide. The valve is attached between tank & nozzle.
11 SOLAR PANEL

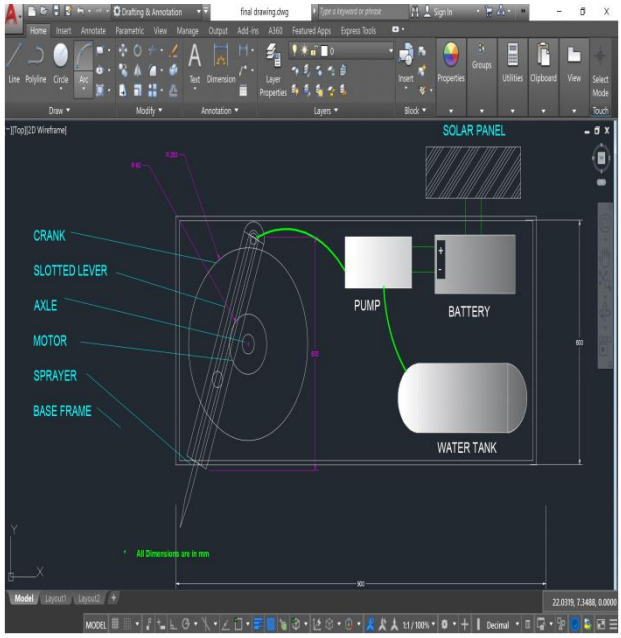
Fig 5.1: Basic Solar Panel

Solar panel refers either to a photovoltaic module, a solar hot water panel, or to a set of solar photovoltaic (PV) modules electrically connected and mounted on a supporting structure. A PV module is a packaged, connected assembly of solar cells. Solar panels can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts.

The efficiency of a module determines the area of a module given the same rated output – an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. There are a few solar panels available that are exceeding 19% efficiency. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring.
Reasons Why Monocrystalline Solar Panels are Used ?
Monocrystalline photovoltaic electric solar energy panels have been the go-to choice for many years. They are among the oldest, most efficient and most dependable ways to produce electricity from the sun.
Each module is made from a single silicon crystal, and is more efficient, though more expensive, than the newer and cheaper polycrystalline and thin-film PV panel technologies.
You can typically recognize them by their colour which is typically black or iridescent blue.

AUTOCAD DRAWING





II. DESIGN CALCULATIONS

MOTOR SELECTION

For our project we are using 0.5 HP MOTOR.
0.5 HP = 372.5 WATTS
RPM of motor = 150
We know that
P = 2 x π x N x T / (60)
372.5 = 2 x π x 150 x T / (60)
T = 23.7261 N.mtr
T = 23726.1 N.mm

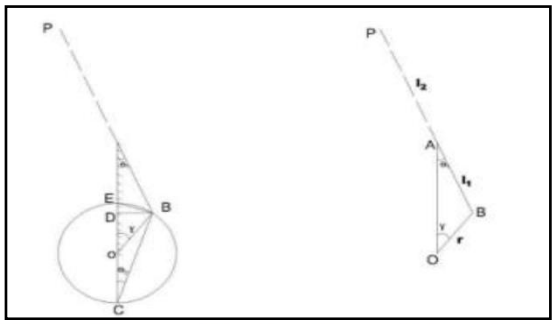
DESIGN OF SHAFT

Now, We know torque is 23726.1 N
Core Dia = dc
Now,
Torque Transmitted to the Shaft
$T = \pi/16 \times (d)^3 \times \tau_{ms}$
$23726.1 = \pi/16 \times (d)^3 \times 35$
$(d)^3 = 3454.21$
d = 15.88 mm
We are selecting Diameter of Shaft 20 mm

CRANK DESIGN

$$\text{Time Ratio} = \frac{Time\ of\ cutting\ \ stroke}{Time\ of\ return\ \ stroke} = \frac{\beta}{\alpha}$$

Forces and angular relationship
Let Θ_1 = inclination of the slotted bar with the vertical γ = inclination of the crank with the vertical
From $\Delta OBC, \angle OBC = \angle BCO$
$= \Theta_2$ (since, OC=OB= crank length, r) Also, $\gamma = 2\Theta_2$ (from triangle's law)
Now from ΔCBE, $\angle B = 90$ (angle in a semicircle)
$CB = CE\cos\Theta_2$ And $CD = CB\cos\Theta_2$



Let Θ_1 = inclination of the slotted bar with the vertical
γ = inclination of the crank with the vertical
From $\Delta OBC, \angle OBC = \angle BCO$
$= \Theta_2$ (since, OC=OB= crank length, r)
Also, $\gamma = 2\Theta_2$ (from triangle's law)
Now from ΔCBE, $\angle B = 90$ (angle in a semicircle)
$CB = CE\cos\Theta_2$
And $CD = CB\cos\Theta_2$
$= CE\cos^2\Theta_2$
Now, $\tan\Theta_1 = \frac{BD}{AD}$, $BD = CD\tan\Theta_2$

$$= \frac{CD\tan\Theta 2}{AD}$$

$$= \frac{CE\cos^2\Theta 2\tan\Theta 2}{AC - CE\cos^2\Theta 2}$$

$$= \frac{CE\sin\Theta 2\cos\Theta 2}{AC - CE\cos^2\Theta 2} = \frac{CE\sin 2\Theta 2}{2(AC - CE\cos^2\Theta 2)}$$

$$\Rightarrow \Theta_1 = \tan^{-1}\left(\frac{CE\sin 2\Theta 2}{2(AC - CE\cos^2\Theta 2)}\right)$$

From above equation we can say that angle travel of nozzle is depends on the lever length.
Taking lever length
AC = 12 cm
CE = 12 CM
Let Θ2 = 45'
Putting value in above equation
Θ1 = tan-1 (0.5)
Θ1 = 26.56 degree
so our nozzle will cover 26.56 degree on each side from the cranck
Total travel will be 53.13 degree.

BATTERY SELECTION

We are selecting 12v DC battery which is sufficient to operate our pump.

DISCHARGING TIME

Discharging Time = Battery AH X Battery Volt / Applied load.
For our battery, Discharging Time = (7.5 AH X 12V) / (0.5 AH X 12 V)
= 15 hrs (with 40% loss at the max)
Final Time taken for discharge = 12 x 40 /100 = 6 hrs
For sure, the backup will lasts up to 6 hrs.

We are using heavy duty battery which is 12V DC and 7.5 Amp-Hr rate, which perfect as per our design criteria.

TECHNICAL SPECIFICATIONS OF THE BATTERY:-

- Weight of the battery : 2 kg.
- Cost of the battery : Rs.900-950
- Output power : 84 watt.
- Operating voltage : 12v
- Current : 7.5 Amp
- Constant Voltage Charge with voltage regulation(27^{o}C)
- Standby Use:- 13.6V-13.8V
- Max. Initial Current:-1.4A

III. CONCLUSION

- With our design one can cover whole area than normal nozzle system. one can also change the angle of oscillate with help of lever and crank mechanism.
- As 70% of population of our country lives in villages & their main occupation is agriculture. My prominent aim of this paper is to fulfill the tasks like hand spraying, IC engine spraying, and leg pump spraying etc. using non-conventional energy sources.
- Thus solar operated spray pump will help the farmers of those remote areas of country where fuel is not available easily.
- They can perform their regular work as well as saves fuel up to large extent. At the same time they reduce environment pollution. Thus saving revenue of government & also most demanded fuel.
- The developed system used for spraying the fertilizer, pesticides, fungicides and painting.

REFERENCES

[1] Sukhatme, S.P., "Handbook of solar energy", New Delhi, Tata McGraw-Hill: ISBN 0-07-462453-9, 2001.

[2] World Energy Outlook, Paris: IEA, 2015. Retrieved on 24/06/2017.

[3] Akshay, M.N. and Waghmare, G., "Design and fabrication of solar operated sprayer for agricultural purpose"National Conference on Innovative Trends in Science and Engineering, Vol. 4, No. 7, 2016.

[4] Pritam J.M., Yogesh G.A., Akash S.B. and Rajendra S.k., "Solar operated spray pump" International Research Journal of Engineering and Technology (IRJET), Vol. 03, No. 02, 2016.

[5] Joshua, R., Vasu, V. and Vincent, P., "Solar Sprayer - An Agriculture Implement", International Journal of Sustainable Agriculture 2 (1): 16-19, 2010.

[6] Chavan, R., Hussain, M., Mahadeokar, S., Nichat, S. and Devasagayam D., "Design and construction of solar powered agricultural pesticide sprayer" International Journal of Innovations & Advancement in Computer Science, Vol. 4, No. 4, 2015.

[7] Pritam J.M., Yogesh G.A., Akash S.B. and Rajendra S.k., "Solar operated spray pump" International Research Journal of Engineering and Technology (IRJET), Vol. 03, No. 02, 2016.

[8] S.Charvani, K.Sowmya, M.Malath, P.Rajani4, K.Saibaba "Design And Fabrication Of A Solar Sprayer" National Conference on Innovative Trends in Science and Engineering, page

