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Fabrication of Multi-Nozzle Automated Pesticide Sprayer

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ABSTRACT
India is said to be agriculture base country directly or indirectly 75% of the people are depending on farming in this agriculture sector there is a lot of field work such as weeding, reaping, sowing etc. A part from this operations, spraying is also an important operation is performed by the farmer to protect the cultivated crops from insects, pests' fungi and diseases for which various pesticides, fungicides and nutrients are sprayed on crops for protection.
In agricultural sector generally farmer uses traditional way that is spray carried on backpack and spraying crop. This becomes time consuming, costly and human fatigue is major concern, these problems can be overcome by using agricultural reciprocating multi sprayer. It facilitates uniform spread of the chemicals, capable of throwing chemicals at the desired level, precision made nozzle tip for adjustable stream and capable of throwing foggy spray depending on requirement. In our project we use slider crank mechanism to convert rotary motion into reciprocating motion to operate the pump, thus the pesticide is spread through the nozzle. This work gives continuously flow of pesticide at required pressure and height. A special arrangement is implemented in this project to adjust the pressure as high or low. By using agricultural sprayer, spraying time and human efforts reduces and results in cost reduction.
Keywords—Back pain, constant flow valve, Multi Nozzle spray pump, farming, pesticides, farm equipment, Spraying equipment, etc.

I. INTRODUCTION

India is set to be an agricultural based country approximately 75% of population of India is dependent on farming directly or indirectly. Our farmers are using the same methods and equipment for the ages e.g. seed sowing, spraying, weeding etc. There is need for development of effective spraying and weeding machine for increasing the productivity. India is a land of agriculture which comprises of small, marginal, medium and rich farmers. Small scale farmers are very interested in manually lever operated knapsack sprayer because of its versatility, cost and design.

Generally farmer uses traditional way that is spray carried on backpack and spraying crop this becomes time consuming, costly and human fatigue is major concern. Present day in agriculture the sprayers play an important role in spraying pesticide. Although sprayers varies like motorized, hand operated. Spraying pesticide is an important process in farming. Now days, there are many types of pesticide sprayer already in market. For the different types of pesticide sprayer there are have a different shapes, sizes, method to carry it but the function are same. The current idea on sprayer in our project is to utilize effectively for reducing time of spraying, human efforts and cost of spraying.

The mechanism involve in this sprayer is reciprocating pump, and nozzles which were connected at the front end of the spraying equipment. A special arrangement is implemented for adjusting the pressure as low and high with the help of adjusting the nut. In Agricultural sector use of cheap and beneficial equipment for effective spraying for increase productivity which is very important for better contribution for India's GDP.

The aim of developing such a concept is primarily because of preventing the 3 major drawbacks of the pump being used currently firstly, the farmer has to

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carry the entire weight of the pesticide spraying (approx.20+ kg) pump on his shoulders; Secondly, he has to continuously use his one hand to pump using the handle; thirdly reduction in spraying time. All these factors have been taken care of in this project along with being cost effective, light in weight and good in strength.

COMPONENTS

The components that are used in the project multi nozzles automated pesticide sprayer are as follows;- Reciprocating Pump, Nozzle, Storage Tank, Wheel, Sprocket, Chain, Crank, Connecting rod, Frame.

a. Reciprocating Pump

These types of pump operate by using a reciprocating piston. The liquid enters a pumping chamber via an inlet valve and is pushed out via an outlet valve by the action of the piston or diaphragm. Reciprocating pumps are generally very efficient and are suitable for very high heads at low, flows.

b. Nozzle

The nozzle is a critical part of any sprayer. Nozzles perform three functions:

- Regulate flow.
- Atomize the mixture into droplets.
- Disperse the spray in a desirable pattern.

The hydraulic spray nozzle used in the application of pesticides has several functions. One of its main purposes is to convert the spray solution into droplets for efficient target coverage. The target may be foliage, bark, stumps, soil or insects. In association with other variables, e.g. height above target, travelling speed, operating pressure, the nozzle also has a role in spray pattern delivery, volume rate delivered and sprays quality produced.

c. Storage tank

Tanks are typically made of impermeable plastic, or stainless steel. Tanks should be designed for easy filling and cleaning. It is a requirement that filler caps be lockable. Further, all tanks are required to be fitted with a device that maintains an air gap to prevent back flow from the tank into a water supply. As an alternative, the fill hose can be equipped with an automatic back pressure shut-off device. The tank is also required by regulation to have an easy-to-read accurate sight gauge or other external means of determining the internal level.

d. Wheel

A wheel is a circular component that is intended to rotate on an axial bearing. The wheel is one of the main components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labour in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel and flywheel.

e. Sprockets

The name sprocket applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed directly, and differs from a pulley in that sprockets have teeth and pulley are smooth. We use freewheel and chain wheel for chain and sprockets arrangement.

f. Chain

The chain is made of steel which is used to transmit power from gear sprocket to pinion sprocket, and it has a no slip.

g. Crank

The function of crank is to transfer motion from prime mover to connecting rod for further operation. Here the circular disk having eccentricity at which rotary motion of crank is converted in to reciprocating motion of connecting rod.

h. Connecting rod

The main function of connecting rod is to convert rotary motion in to reciprocating motion. Here connecting rod convert rotary motion of crank to reciprocating motion of pump and extension rod.

i. Frame

The main function of frame is to carry whole assembly on it so it has to be strong enough to hold it. The frame is made of square tube and it formed out of mild steel.

CAD DESIGN

Fig, Isometric view of 3D model

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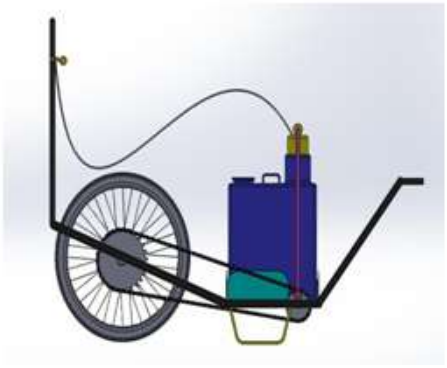

Fig. Side view of 3D model

LIST OF MATERIALS

SL.NO	NAME OF PARTS	QUANTITY
1	Water tank	1
2	Nozzles	4
3	Connectors	4
4	Cable	4m
5	Wheel	1
6	Bearing	4
7	M S Steel sq. tube	20m
8	Sprocket and Chain	2+1

FABRICATION MODEL

Fig, Fabricated model

WORKING PRINCIPLE

The operator grabs the handle and pushes the cycle forward as cycle moves forward, the wheel rotate. When the wheel rotates then the gear sprocket mounted on wheel is also rotate at same speed. The chain drive transfers the motion of gear sprocket to pinion sprocket.

The pinion sprocket and crank is mounted on either side of same shaft, the rotary motion of shaft is converted into the reciprocating motion with the help of crank and connecting rod mechanism. The connecting rod is also connected with lever and then the lever oscillates at fulcrum.

The piston connected at fulcrum produce reciprocating motion in cylinder and the required pressure is achieved. The pesticide from tank suck sin cylinder and piston forced the pesticide to nozzle through the pipe; the numbers of nozzles are connected to spray the pesticide. We can adjust the pressure, which is required for spraying with the help of special arrangement is to change the length of crank by providing slot on crank. By providing some adjustment at joint of connecting rod and lever free rotation of crank or neutral position can be achieved.

Single Slider Crank Mechanism: The Slider-Crank Mechanism is used to transform rotational motion into translational motion by means of a rotating drive beam, a connecting rod and a sliding body.

In another word Single Slider Crank Mechanism is used to transform straight line motion (Reciprocating Motion) into rotary motion and vice versa.

Working Methodology

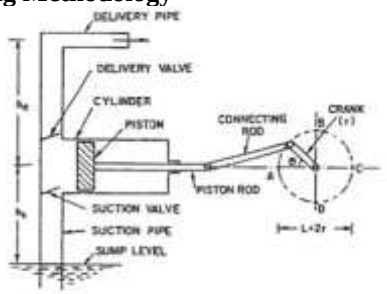

Fig Reciprocating pump

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MANUFACTURING PROCESSES

Manufacturing involves turning raw material to finished products, to be used for various purposes. There are a large number of processes available. These processes can be broadly classified in to four categories.

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i. Welding
ii. Grinding
iii. Cutting operation
iv. Drilling
v. Fabrication

DESIGN OF THE SPRAYING MACHINE
DESIGN OF FRAME:
Length of frame = (centre dist. between two sprockets) + (width of tank) + (Excess) = 250 + 310 + 30
L = 590 mm
Height of Frame = 630 mm
Width of Frame = 450 mm
Total length of pipe = (590*2) +200+(600*2) +1000+(690*2) +100 = 4960 mm
Cross section area of square pipe = 20*2 = 40*4 =160 mm²
Volume of frame = 160*4960 = 748800 mm³
Density of Mild Steel material = 7.7*10-6 kg/mm³
Density = Mass/volume
Mass = density*volume=7.7*10-6*748800 = 5.76 Kg
Total weight of assembly = 16+2+1+6 = 25kg *9.81 = 245.
Yield stress of material = 247 N/mm^2
Area = 4960 * 20 = 99200 mm2
Stress = 245.29/99200= 0.0027 N/mm2
Therefore, 0.0027< 247 N/mm², hence the design is safe.

DESIGN OF WHEEL
Distance between two plants = 1 feet
= 30.48 cm.
Line covered by one rotation of wheel = 4
30.48 * 4 = 122 cm
122 = 2πr
r = 122/2π
r = 19.5cm

SELECTION OF PINION
Minimum no. of teeth available on pinion = 18
Outer dia. Of pinion = 8 cm = 80 mm
Inner dia. Of pinion = 6.5 cm = 65 mm
Pitch circle dia. (Dp) = (Do-Di/2)+Di
Dp = (80-65/2) + 65= 72.5 mm
Gear Ratio = 1:3
On rotation of gear sprocket gives three rotation of pinion sprocket, we required three strokes to generate adequate amount of pressure.

SELECTION OF GEAR SPROCKETS
(1/3) = (tp/tg)
(1/3) = (18/tg)
tg=18*3
tg = 54
(tp/tg) = (Dg/Dp)
(3/1) = (dg/72.5)
Dg=218mm
Length of connecting rod = 480mm
Dia of crank wheel = 230mm

II. LITERATURE REVIEW

1. Dr. R. D. Dhete' s research paper on types of spraying mechanisms describes various types of mechanisms that are being used in the industry for spriaying of chemicals and they can be useful.
2. Different types of Spraying mechanisms were also referred from a research work published by Massey University New Zealand.
3. The methodology for calculation of design work were studied and analysed from a paper on "Mannually operated Multi-nozzle sprayer" by Rushikesh Ghadge, Savitribai Phule Pune University & Sandeep H. Poratkar, from Tulsiramji Gaikwad Patil College of Engg & Technology titled "Development of Multinozzle Pesticides Sprayer Pump"

LIMITATIONS
1. In irregular area of land, it could be difficult to operate sometimes.
2. On rainy day in a muddy environment it is difficult to operate.
3. For irregular crops this pump is difficult to work. The flow is not uniform, so we have to fit a bottle at both ends.
Note :- These Limitations can be removed by doing some minor changes

FUTURE SCOPES
- Work reliably under different working conditions.
- Decrease labor cost by advancing the spraying method.
- Machine can be operated in small farming land (5 acre).
- Making such a machine which can be able to reduce spray time.
- Maximum area of spraying in minimum time.
- Proper adjustment facility with respect to crop size & height.
- Attach the multiple nozzle & trolley.
- System is eco-friendly by using a spray guard for spraying.

III. CONCLUSIONS

It is upgraded design of manually operated sprayer which will be helpful for small land farmers. It consumes

less time and saves money as compared with conventional spraying and weeding. This machine does not require
any fuel or power so maintenance is less.

- The suggested model has removed the problem of back pain, since there is no need to carry the tank on the
backbone and solder.
- More no.of nozzle which cover maximum area of spray in minimum time at maximum rate.
- Proper adjustment facility in the model with respect to crop helps to avoid excessive use of pesticides which
result into less pollution.
- Imported hollow cone nozzle should be used in the field for the better performance.
- Muscular problem is removed and there is no need to operate lever.
- This alone pump can use for multiple crops.
- It is little heavy but efficiently working in rough conditions of farm. It is economical therefore affordable for
all kind of farmers.
- It requires comparatively less time for spraying so we can get more fields spraying per day. It is cost effective
than the existing spraying pumps available in the market as no direct fuel cost or cost for maintenance is needed
for this.
- The performance of the equipment will increase when it is operates on the smooth surface or less uneven
surface and also it will be more effective when it is used on the crops having nearly similar height and having
the less space between two crops.

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