Scientific Journal of Impact Factor (SJIF): 5.71
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406
International Journal of Advance Engineering and Research Development
Volume 5, Issue 05, May -2018

WHEEL OPERATED FERTILIZER SPRAYER

Ashish Prakash Borhade[1], Prakash Madhukar Sutar[2],Susheel Pote[3], Sharad Eknath Bodke[4]

[1]*Department of Mechanical Engineering, Sandip Institute of Engineering and Management, Nashik*
[2]*Department of Mechanical Engineering, Sandip Institute of Engineering and Management, Nashik*
[3]*Department of Mechanical Engineering, Sandip Institute of Engineering and Management, Nashik*
[4]*Department of Mechanical Engineering, Sandip Institute of Engineering and Management, Nashik*

Abstract —*India is an agrarian country. On an average about 60 to 70% of the Indian population depends directly or indirectly on agriculture for their income or we can say basic needs (food, cloth and shelter). In this agriculture sector there is a lot of field work, such as weeding, reaping, sowing etc. Apart from these operations, spraying is also an important operation to be performed by the farmer to protect the cultivated crops from insects, pests, funguses and diseases in which various insecticides, pesticides, fungicides and nutrients are sprayed on crops. Also there is growth of unwanted herbs/weeds in the fields which affects the development of crops cultivated. Therefore, herbicides are also required to be sprayed on open fields before sowing to meet the demand for quality and quantity of crops. And this spraying is done with the help of sprayer. So, this research work aims at designing and manufacturing the sprayer which operates with minimal effort and better ease.*

Keywords- *Fertilizer Sprayer, Wheel operated Trolley, Slider crank mechanism, Compression Chamber, Chain and Sprocket*

I. INTRODUCTION

In Maharashtra, particularly in Vidarbha region the crop yields are generally low. Though, the extent of loss of yield due to individual constraints is not known, the contribution of insects, pests and diseases cannot be neglected. Further, environmental conditions such as longer durations of rainfall, cloudy weather etc. which are there sometimes create a favorable environment for faster growth of insects, pests and disease. Therefore, the use of pesticide is an absolute necessity to meet the demand for quality and quantity of crop production. Apart from this, crops in this region also require spraying of some growth enhancing nutrients to them; when there is very low rainfall. So for increasing the productivity of the crops there is a need to use an effective sprayer for spraying of various things.

II. FIELD SURVEY

To know the need and importance of spraying in agriculture sector, we have done field survey in Akola district region near our village Mhaisang. There we found that most of the farmers have non-irrigated fields. Also farmers in these regions cultivate crops like cotton, grams, tur, green gram, black gram, soya bin etc. Also we came to know that the average spacing between two rows of crops like cotton, pigeon pea (tur) etc. is 2.5 to 3 feet. The information collected about spraying insecticides, pesticides is combined in following table:-

Sr. No.	Crop name	Average no. of times spraying required during life
1	Cotton	4-5 times right from the beginning
2	Tur dal (pigeon pea)	3-4 times.
3	Black gram	2 times
4	Green gram	2 times
5	Bengal or split Gram (harbhara)	4-5 times
6	Soyabin	2 times
7	Jwari	Hardly once

Table 2.1 Spraying requirement for various crops

III. LITERATURE SURVEY

1. Ms.Ashwini Kambar, Ms.NOOTAN S. KANKANAWADI, MS. POOJA B. NERLI, MS. SHWETHA S. PATIL worked on "DESIGN AND DEVELOPMENT OF DUAL CONTROLLED, SOLAR POWERED, SMART PESTICIDE & FERTILIZER SPRAYING ROBOT.
2. Vishakha Bodke , Mahesh Gaikwad, Pratibha Patil , Karan Pawar , Prof. Firdos J. Khan worked on "Multipurpose Manually Operated Automatic Spraying and Fertilizer Throwing Machine"
3. Shivaraja kumar. A , Parameswaramurthy. D worked on "DESIGN AND DEVELOPMENT OF WHEEL AND PEDAL OPERATED SPRAYER"
4. Varikuti Vasantha Rao , Sharanakumar Mathapati , Dr. Basavaraj Amarapur worked on "Multiple Power Supplied Fertilizer Sprayer"
5. Dhiraj N. Kumbhare, Vishal Singh , Prashik Waghmare , Altaf Ansari , Vikas Tiwari , Prof. R.D. Gorle worked on "Fabrication of Automatic Pesticides Spraying Machine"

IV. COMMENTS

Literature survey shows that every author has tried to reduce the efforts while spraying the fertilizer on the crops. To reduce the efforts they have used various options to achieve the function of spraying. It can be by achieved using robotics or it can also be achieved by using pedal operated vehicle. No any author has incorporated use of slider crank mechanism using chain drive. So we have gone for the use of slider crank mechanism and chain drive to achieve the goal of fertilizer spraying with ease and maximum efficiency.

V. PROBLEM DEFINITION

Objective of the present work is to design and develop wheel operated fertilizer sprayer, which operates on the motion produced by wheels of the trolley. On the shaft of those two wheels one sprocket is mounted. Rotary motion of that sprocket is converts into reciprocating motion by using slider-crank mechanism. By using this reciprocating motion fertilizer is compressed at sufficient pressure in compressor. This compression process will divide that fertilizer into tiny particles. And thus by using few nozzles this fertilizer is sprayed on the crops**.**

VI. METHODOLOGY

Power Sprayer, a modified model has been designed and introduced for effective operation without fossil fuel and minimum physical inputs of operator. In this modified model the tank with compression chamber is placed on the trolley and with the help of some suitable driving assembly and mechanism piston is oscillated to create pressure in cylinder of sprayer. Thus we are trying to reduce the efforts of operator in carrying the sprayer weight during spraying in fields and in actuating lever. The overall view of the modified model fertilizer sprayer and trolley is as shown in fig.

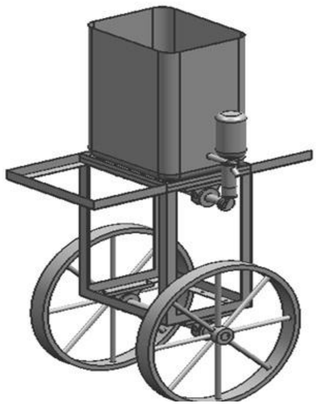


Fig. modified model fertilizer sprayer and trolley

VII. MATERIAL SELECTION

Most of the material which we have used is mild steel. Mild steel is composition of iron and carbon content up to maximum of 1.5% the carbon occurs in the form iron carbide because of its ability to increase the hardness of strength of steel.

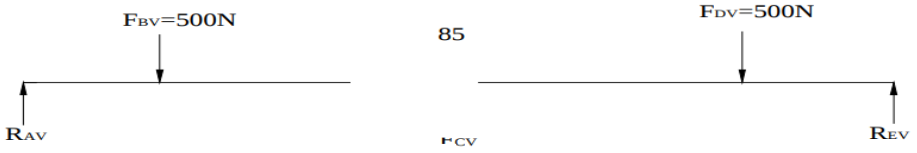
VIII. DESIGN PROCEDURE

8.1 Design of driving shaft:

Total weight on shaft =100kg x 9.81

=981N ≈1000N

As shown in fig the shaft consist of 5points, where at point B and D, the force is applied on the shaft.



= 170

Fig. 8.1 Vertical Loading Diagram for driving shaft

F_{cv} is vertical force applied by the chain sprocket on the shaft. The reactions will be offered on the wheels, i.e. R_{AV} and R_{EV}. The vertical force calculated by reverse engineering on sprocket is 170N. Thus, F_{CV} =170

As the geometry is symmetric, $R_{AV} = R_{ev}$ = (500 +500 -170)/2 =415N

Now power developed on the shaft, P =F_m x V Where, F_m = force applied on the shaft. V = velocity of the man.

Generally, man can apply force up to 400N by single hand. We are designing sprayer to be pushed by double hands.

Thus, F_m = 400+400 =800N

General walking speed of a man with pushing a load= 0.6m/s

Thus, P = 800 x 0.6 =480watt

Equivalent torque is given by

$Te = \sqrt{T^2 + M^2}$ Where T= Torsional moment. M= Bending moment.

Angular velocity of wheel is given by,

ω = V/R Where, V = velocity in m/s and R = Radius in m.

The diameter of selected wheel =0.64m

Thus radius R= 0.32m

Angular velocity ω = 0.6/ 0.32 =1.875 rad/sec

Power is also given by,

P= Torque x ω T = P/ ω =480/1.875 T= 256 N-m ……….(1)

Calculation for bending moment:

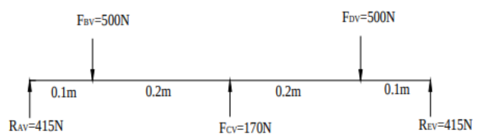


Fig. 8.2 Shear force diagram for driving shaft

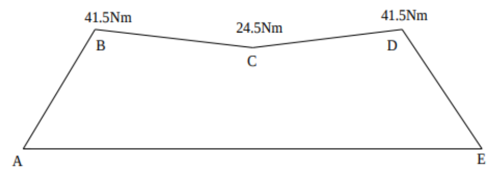


Fig. 8.3 Vertical bending moment for driving shaft

Vertical bending moment,

M_B = 415 x 0.1 = 41.5N-m

M_C= (415 x 0.3) – (500 x 0.2) = 24.5N-m

M_D =415 x 0.1 =41.5N-m

Thus maximum bending moment,

M= 41.5N-m ………………(2)

From equation (1) and (2),
Equivalent Torque,
$Te = \sqrt{T^2 + M^2}$ Te =259.3N-m ≈ 260N-m

Diameter of shaft-
τ_{max} for mild steel is, 55N/mm^2 x 0.75 =41.25 N/mm^2
Te = 260 N-m = 260 x 10^3 N-mm FOS =1.2 (Agricultural)

$T_{max} = T_e$ x FOS = 312 x 10^3 N-mm

$$\tau_{max} = \frac{16T_{max}}{\pi d^3} \quad d^3 = \frac{16T_e}{\pi \tau_{max}} = \frac{16x312x10^3}{\pi x41.25}$$

d^3= 38521.28 d = 33.77 mm d ≈ 34 mm
For more strength we selected 'd' = 35 mm

8.2 Design of driven shaft:
Driven shaft was designed by using same methodology which was used in case of driving shaft. Diameter of shaft comes out to be,
d ≈ 34 mm For more strength we selected d = 35 mm

5.3 Bearing selection:

F_r= 500 N	d= 35 mm	K_a=1.5

Life of Bearing for Agriculture machinery is between 4000-8000 hr
L_h= 8000 hr
L= (L_h x 60 x n)/10^6
= (8000x 60x 18)/10^6
= 8.64 million revolution.

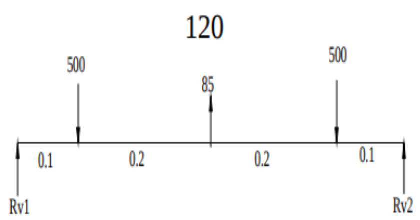


Fig. 8.7 Vertical load Diagram for bearing

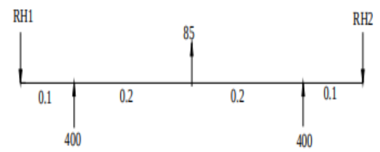


Fig. 8.8 Horizontal Load Diagram for bearing

Taking moment about 1
(500 x 0.1) – (120 x 0.3) + (500 x 0.5) – (R_{v2} x 0.6) =0
R_{V2} = 440N R_{V1} = 440N
(400 x0.1) + (400 x0.5) – (R_{H2} x0.5) =0
R_{H2} = 400N R_{H1} = 400N

R_1= $(R_{V1}^2 + R_{H1}^2)^{1/2}$ R_1 =594.64N R_2 =594.64N

F_r =594.64N P_e =594.64 x1.5 = 891.964N
c= $P_e (L_{10})^n$
c= $P_e (L_{10})^{0.333}$ ……………. For ball bearing
c= 1.828 kN
$c_{calc.} < c_{all}$ (15.9 kN)
so bearing 6007 is selected

5.4 Chain selection:

From manufacturers catalog chain is selected as follws:

1) Select chain from manufacturer's catalogue having required power rating:

Chain no.	25	35	40	41	***50***	60
50rpm Power rating	0.03	0.11	0.27	0.14	***0.53***	0.91
100rpm Power rating	0.06	0.21	0.5	0.28	***0.98***	1.70

Table 8.2 Type A: manual or drip lubrication.

8) Find dimensions of selected chain from manufacturer's catalogue :

ANSI chain no.	Pitch	Roller diameter (d_i)	Width (w)	Breaking strength (N)
41	12.7	7.94	7.94	13920
50	***15.875***	***10.06***	***9.52***	***21700***
60	19.05	11.91	12.7	31300

Table 8.3 chain from manufacturer's catalogue

ANSI chain number 50 having Power rating 0.53 is selected.

a)For chain number 50 (ANSI):	b)Number of chain links (M)=69	c)Pitch circle diameter of sprocket pinion:
P =15.875 roller diameter d_1 =10.06 mm width W =9.52 mm bearing strength = 21700 N	for C = 400 mm ……..assumed Length of chain: L = M x P = 69 x 15.875 =1095.38 mm	$D = \frac{15.875}{\sin(\frac{360}{2*18})}$ D_1 = 91.42 mm P_d =0.528 kW As, for selected chain $P_{max} > P_d$ So, chain drive is safe to transmit power

5.5 Design of Key:-

Square key: Usual Proportion of square key W=H=D/4 =35/4 =8.75 mm

Checking for shear stress:-

Shear stress (τ_{max}) for mild steel = 55 N/mm^2 T_{max} =312 x 10^3 N-mm

Length of key slot = 70 mm

$$\tau_d = \frac{2T_{max}}{dwl} = \frac{2x312x10^3}{35x8.75x70} = 29.10 \text{ N/mm}^2$$

As $\tau_d < \tau_{max}$ Hence, the design for shear stress is safe.

Checking for compressive stress:-

Stress (σ_{max}) for mild steel = 110 N/mm^2 T_{max} =312 x 10^3 N-mm Length of key slot = 70 mm

$$\sigma_d = \frac{4T_{max}}{dhl} = \frac{4x312x10^3}{35x8.75x70} = 58.21 \text{ N/mm}^2$$

As $\sigma_d < \sigma_{max}$ Hence, the design for compressive stress is safe.

5.6 Grip Diameter:

Various hand tools like khurpi, dao, sickle etc. and manually operated equipment like power tiller, weedier, sprayer etc. are used for various agricultural works. Handle is one of the important components in the hand tools and equipment. For operation of the hand tools and manually operated equipment, the handle is grasped such that finger and thumb flex around the handle. Anthropometrically, the diameter of the handle should be such that while an operator grips the handle, his longest finger should not touch the palm. At the same time, it should not exceed the internal grip diameter. Thus the handle diameter will range between 3.1 and 4.2 cm, 3.1 cm being the 95th percentile value of the middle finger palm grip diameter and4.2 cm the 5th percentile value for internal grip diameter. Based on the studies of men and women with reference to an ergonomic evaluation of different hand tools with household appliances, it had been found that to allow good grip on handle, the diameter of the handle should be a little lesser than the inside grip diameter. Therefore, the recommended handle diameter is 3.7 cm.

5.7 Handle Height:

The handle of the push-pull type equipments should be designed such that during operation the operator stands erect as far as possible to reduce musculo skeletal discomfort. For operating push-pull type equipments K.N. Dewangan (2010) has recommended the handle height to be within 0.7 and 0.8 of shoulder height for minimum physiological cost and muscular fatigue. Considering this range, a handle height of 100.0 cm is recommended for male agricultural workers.

IX. FABRICATION

The main processes used for the fabrication are cutting, turning, welding, drilling and grinding. By performs all above operations the trolley was manufactured and spraying unit is fitted on trolley.

X. MODEL AND WORKING

- ✓ When we push the sprayer trolley, work done by the pusher get transmitted first to wheels, due to which wheels rotate and trolley proceeds further.
- ✓ Because of this, the power applied is get transmitted to driving shaft attached to main wheels.
- ✓ This drives the driving sprocket attached to it, giving rotational motion to it.
- ✓ Rotational motion of driving sprocket is then transmitted to driven sprocket by means of chain drive.
- ✓ This driven sprocket thus transmits power to the driven shaft and thus to crank attached to it and it rotates.
- ✓ Crank transmits motion through connecting rod to the slider attached to it inside cylinder of pump producing pressure required for spraying and thus we will get the output.

XI. Results and Discussion

- ➢ This machine reduces effort of man by automatic pumping by rotation of wheel.
- ➢ The model can be easily operated by a single user/ operator.
- ➢ The model can be easily fabricated.
- ➢ The model requires less physical input from the user.
- ➢ It is eco-friendly as no fuel is required for operating it.
- ➢ It reduces labor and operating cost effectively.
- ➢ It is cheaper than pumping by using power from tractor or motor because it does not require external electrical or mechanical power.
- ➢ The model is suitable for treating small areas such as nurseries, greenhouses and vegetable gardens.

XII. Future Scope

Push type spraying machine is fabricated and operated successfully. Still there is a scope to do some modifications which will make it more effective. In the current model we have used shaft in driving assembly therefore the ground clearance we getting is less. If we use shaft less assembly then we can get higher ground clearance. Also in such assembly we can provide arrangement for adjustment of width of machine according to requirement. This will reduce damage to crops.

I. REFERENCES

[1] Ms.Ashwini Kambar, Ms.NOOTAN S. KANKANAWADI, MS. POOJA B. NERLI, MS. SHWETHA S. PATIL, "DESIGN AND DEVELOPMENT OF DUAL CONTROLLED, SOLAR POWERED, SMART PESTICIDE & FERTILIZER SPRAYING ROBOT.

[2] Vishakha Bodke , Mahesh Gaikwad, Pratibha Patil , Karan Pawar , Prof. Firdos J. Khan, Volume 5 Issue IV, April 2017, IJRASET, "Multipurpose Manually Operated Automatic Spraying and Fertilizer Throwing Machine"

[3] Shivaraja kumar. A , Parameswaramurthy. D, IIJME, Volume 2, Issue 6, June 2014, DESIGN AND DEVELOPMENT OF WHEEL AND
PEDAL OPERATED SPRAYER".

[4] Varikuti Vasantha Rao , Sharanakumar Mathapati , Dr. Basavaraj Amarapur, nternational Journal of Scientific and Research Publications, Volume 3, Issue 8, August 2013, “Multiple Power Supplied Fertilizer Sprayer”
[5] Dhiraj N. Kumbhare, Vishal Singh , Prashik Waghmare , Altaf Ansari , Vikas Tiwari , Prof. R.D. Gorle, “Fabrication of Automatic Pesticides Spraying Machine”

