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Eco-friendly Mechanically Operated Multipurpose Spray Pump

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Abstract:- As on today the whole world is facing a problem of energy crisis. If we want to continue for prolonged use of energy then we must try to save it as much as we can whether it is on large scale or small scale. In today's world, we use various spraying technologies involving use of electrical energy, chemical energy of fuels. This fact makes us know that how large content of energy is getting used at such a places where mechanical energy can be used instead of direct energy sources. This is a reason why we have implemented some mechanical sprayers getting powered by human effort. Although these are serving the purpose, their range of working is not enough. They take considerably larger time for spraying. Thus what we have aimed is to design such a technology which will run on mechanical power but requiring less time for spraying than those which are hand operated. Thus considering today's demand, we have come up with mechanically operated multipurpose spray pump which is purely mechanical. This device is having the advantage of taking less time for spraying once it starts. If we want to decrease the time further we just need to increase size of our piston and no. of nozzles with relative change in effort. In addition to all this we are implementing soil coulter along with spray pump so we can have double advantage.

Keywords- Spray pump, eco friendly, spray materials

I. INTRODUCTION

Farming is the backbone of Indian economy. 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 for which various insecticides, pesticides, fungicides and nutrients are sprayed on crops for protection. Farming has undergone a great evolution in last 50 years. Out of the various reasons involved for this evolution is control of various diseases on crops. During initial days there was only hand spraying people use to do. Then slowly there has been development of various methods to spray out chemicals and dusts. Though these devices were highly efficient, there is a need to have certain changes. Chemicals are widely used for controlling disease, insects and weeds in the crops. They are able to save a crop from pest attack only when applied in time. They need to be applied on plants and soil in the form of spray, dust or mist. The chemicals are costly.

Therefore, equipment for uniform and effective application is essential. Dusters and sprayers are generally used for applying chemical. The application of pesticide is one of the most frequently used methods to protect crops and trees against diseases and insects in agriculture. In the modern agriculture, the usage of pesticides is still increasing, moreover the 90% of these pesticides are being applied in the form of liquid spray and mostly by using the pressure gained from direct energy sources like electrical energy, chemical energy. Increasing public concern about the potential damage of chemical and electrical inputs in agricultural spraying systems has challenged industry to develop new and effective methods of spraying which will maintain environment friendly approach.

The argument for using existing conventional equipment is that farmers will face economical difficulties in case of chemical and electrical powered pumps as well as they will face difficulties in case of hand operated pumps. One way to overcome this problem is to use the equipment developed for application of the pesticides through the use of mechanical power. In selecting a pump for furnishing a supply of pesticides for farm use, or for spraying insecticides, herbicides or fungicides, we must be sure it is designed for the job to be done. The pump should have sufficient capacity to supply the needed amount of water and spray material in the allowable time. Spraying is employed for a variety of purposes such as application of:

i. Herbicides in order to reduce competition from weeds,

ii. Protective fungicides to minimize the effects of fungal diseases,
iii. Insecticides to control various kinds of insects, pests,
iv. Micro-nutrients such as manganese or boron.

has double capacity than those of the other mechanical devices with ease of operation. The spraying equipment we are concerned about is used only for liquid spraying. The main function of our equipment is to use mechanical power to break the liquid into droplets of effective size and distribute them uniformly over the surface or space to be protected using various power transfer units. There are various types of spraying equipments like hand sprayer, stirrup pump sprayer, hand compression sprayer, rocker sprayer, foot sprayer, knapsack sprayer, powered sprayers, motorised knapsack mist blower, tree sprayers, blower sprayer, power tiller mounted orchard sprayer, tractor mounted sprayer, self propelled light weight boom sprayer, aero blast sprayers, hand rotary duster. All the above mentioned types are used for single purpose which is nothing but spraying. Many of them are direct power devices and others are mechanical devices. The disadvantage with current mechanical devices is their low capacity and difficulty in operation as they have to be carried at back. Our device is double acting which acts as a soil coulter along with spraying purpose. The device

The above mentioned devices have some power source and feeding mechanism which is used for spraying. If we consider various components of this device then we find that these are somewhat similar to those conventional sprayers. Primarily we have four wheels which are for power feeding and supporting a frame, tank and total assembly. We are using same piston and cylinder assembly which is used before. The difference comes in mechanism used for power feeding which consists of cam and follower link. There is also a mechanism used for moving soil coulter. Along with all this we need sprayer producing a steady stream of spray materials in the desired fineness of the particles so that the plants to be treated get covered uniformly. It should be light in handling but enough strong to face every problem with regards to heavy work or maintenance.The main drawback of hand operated spray pump is that the user can not use it for more than 5-6 hours continuously as he gets tired after some hours, whereas fuel operated spray pump requires fuel which is expensive and also there is non-availability of fuel at rural places. At the same time it emits carbon dioxide as pollutant which is harmful to our environment. The goal of our project is to provide an easy way for spraying pesticides in rural areas with such an equipment which is farmer friendly and nature lover.

PROJECT CONCEPT:

To overcome the disadvantages related with previous model, we have designed a model running without any fuel and also easy to operate for a user. In this model we find that we have simply used a cam mounted on rear shaft which will actuate piston inside cylinder. Also we can see a special mechanism used for a soil coulter. The assembly consists of 4 wheels out of which 2 are mounted on rear shaft and 2 are mounted on guide shaft at front. A cam is mounted on rear side exactly at the middle of shaft. A cam profile design is secret as it is a special purpose cam and is designed just to reduce friction as much as it can be.

DESIGN OF VARIOUS PARTS

DESIGN OF SHAFT:

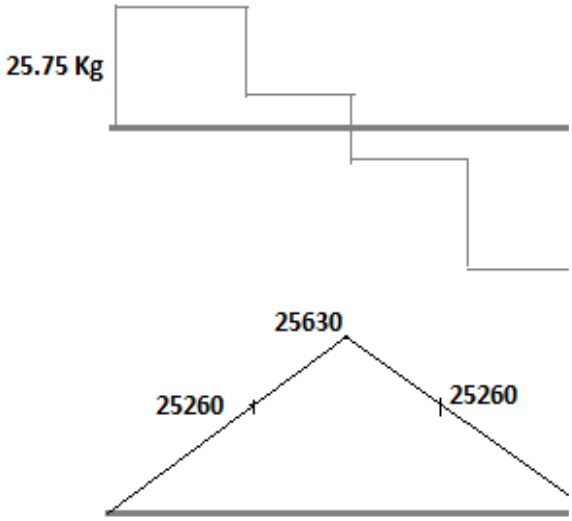


Fig.5.1 Shear force and bending moment analysis under load conditions of shaft

For a main shaft which is a power generator, power is given as,

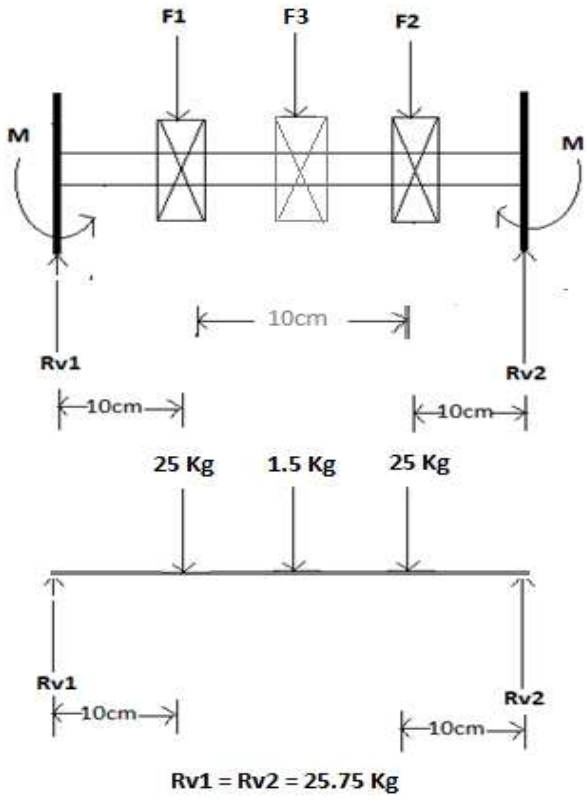
$P = F \times V$ …….. (1)

Our whole assembly will have weight approximately equal to 65 kilograms.

Thus total force acting will be on 4 wheels. Out of those 4 wheels we have maximum load acting on rear wheels mounted on shaft. This shaft is subjected to 50 kilograms of load. So force acting on shaft is given by,

$F = m \times g$

Putting $m = 50$ kg



$g = 9.81$ m/s^2

Thus

$F = 50 \times 9.81 = 490.5$ N

Velocity is found out to be 12 cm/s i.e. $V = 0.12$ m/s

Thus

power, $P = 490.5 \times 0.12 = 58.86$ watts

We know that torque is given as, $T = \frac{P \times 60}{2\pi N}$

Where, N = No. of revolutions = 25 rpm

Thus we have Torque, $T = 22.48 \times 10^3$

For a given shaft we have from shear force diagram,

Vertical reactions at wheels i.e. fixed supports, $Rv_1 = Rv_2 = (25+25+1.5) / 2$

= 25.75 kg

= 25.75 × 9.81 N

= 252.6 N

From bending moment diagram, maximum bending moment is found to be

$M_1 = 25.63 \times 10^3$

The resultant moment on a given shaft is given as

$M = (M_1^2 + T^2)^{1/2}$

$= 34.1 \times 10^3$ N.mm

Also we know that shaft diameter is given as,

$d = [(M \times 16) / (\pi \times \tau)]^{1/3}$

$d = [(34.1 \times 1000 \times 16) / (\pi \times 45)]^{1/3}$ …(since $\tau = 45$ Mpa)

d = 15.68 mm

This is ideal diameter of shaft which is needed. Since a shaft may be subjected to extra load as it has to work in rough conditions and from availability point of view, we chose a safe diameter of 20 mm.

Thus diameter of shaft, d = 20 mm

5.2 VELOCITY AND SWEPT VOLUME CONSIDERATION:

After a trial we have found that safe and maximum velocity for a given device is 12 cm/s

So, V = 12 cm/s

We have piston diameter $d_1 = 3.9$ cm = 0.039 m

Piston stroke $l = 5$ cm = 0.05 m

Thus we have swept volume given as,

$V_s = \frac{\pi}{4} \times d^2 \times l$

$= 59.73 \times 10^{-6}$ m^3 / revolution

No. of revolutions are given as,

$N = \frac{V \times 60}{\pi \times D}$

Where D is maximum cam diameter which is 9 cm

$N = \frac{0.12 \times 60}{\pi \times 0.09}$

N = 25 rpm

Now swept volume in m^3 / s is given as,

$V = V_s \times N$

$= 1.49 \times 10^{-3}$ m^3/min

5.3 MEAN EFFECTIVE PRESSURE DEVELOPED:

Mean effective pressure developed is given as,

$$\text{m.e.p.} = \frac{\text{Power Produced}}{\text{Swept Volume}}$$

Power = 58.86 watts

Swept volume = 1.49×10^{-3} m^3/ min

$$\text{m.e.p. P} = \frac{58.86 \times 60 \times 1000}{1.49} = 2.37 \text{ MPa}$$

5.4 PEDESTAL BEARING DESIGN:

We have stepped shaft which has diameter of 20 mm for mounting wheels while a diameter of 25 mm for accommodating bearing hub. The given pedestal is not designed but it is chosen from available pieces in market. Our device is agricultural one and it is getting supported to 50 kg of load only. Out of available journal types in market a journal
bearing is best suitable for this purpose having internal diameter of 25 mm.

5.5 NOZZLES:

The nozzles we have selected are same as that are used in agricultural sprayers which are already available. The nozzles are made from brass and are non-corrosive. The nozzles are not designed specially and they are standard flat pan nozzles.

5.6 PISTON AND CYLINDER ASSEMBLY:

The piston and cylinder are mainly forming actuating devices for spraying. Their performance decides spraying efficiency. We have selected brass made cylinders with plastic pistons just because they are easily available and economical. Along with this, technically, they are easy in operation.

5.7 TANK:

We want our tank to carry as much fluid as it can be along with its self weight as less as possible. We have taken a tank which is almost 40 litre capacity. A material for tank used is plastic fiber. Plastic fiber is very low in weight as compared to mild steel. It also has very low cost. We have used such a large capacity tank because we wanted to remove disadvantage of conventional sprayers being low capacity ones.

5.8 HAND GRIP DIAMETER:

The handle design should be safe enough and convenient for its holder. 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 and 4.2 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. [6].

5.9 HANDLE CONSIDERATIONS:

The handle which is to be used for our push type apparatus is taken by considering effort required and convenience of user. 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 80 cm is recommended for male agricultural workers [6].

5.10 WHEELS:

The wheel selection was based on economy factor as well as performance factor. The wheels we have selected are not designed but chosen from market best suited to our purpose. They are formed of mild steel and are then fitted with self prepared bush
through steel rods.

5.11 FRAME:

Themain function of frame is to carry whole assembly on it so it has to be strong enough to hold it. It is formed out of mild steel by using welding operation.

6.5 WORKING:

- When we push the sprayer trolley, work done by the wheels get transmitted first to cam and then to follower link, due to which piston reciprocate and starts building pressure.
- This is because the power applied is transmitted to driving shaft attached to main wheels.
- While power is getting transferred to piston, at the same time a coulter come into action and its flaps starting their function.
- As the time passes, a strong pressure gets developed inside cylinder as accumulator helps it in doing that.
- As the pressure gets developed, nozzles start acting and they initiate spraying.
- During this time, a connecting link from coulter also moves its flaps rapidly and soil is taken to the roots of plants.

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7. CONCLUSION:

After having a trial we have found that one finds it easy to operate push type machine. The pump can deliver the liquid at sufficient pressure where output of the nozzle in 1min is 0.3 and spray width 0.4m from calculation so that it reaches all the foliage and spreads entirely over the sprayed surface. 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. Also it can be used for any crop as its maximum width is not more than one foot. Its nozzles can be adjusted to any height so this device can be used for any crop.

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