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FABRICATION OF PEDAL OPERATED RECIPROCATING PESTICIDE SPRAYER FOR AGRICULTURAL AND DRAINAGE LINE USE

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Abstract: A study was undertaken to design and construct a pedal operated reciprocating pump for use in large irrigation project areas and orchard and drainage line. For this purpose, different types of pumps and reciprocating devices were constructed and tested at different suction heads in the laboratory to evaluate their performances. Farmers are using the same methods and equipment for the ages. In our country farming is done by traditional way, besides that there is large development of industrial and service sector as compared to that of agriculture. The spraying is traditionally done by labor carrying backpack type sprayer which requires more human effort. Pedal operated reciprocating pump operation, less input power was needed and it can be operated by one adult man for a long time (more than 2 hours) continuously without being tired. The pedal operated reciprocating pump can be available by local markets and simple skills required to manufacture it. It would be suitable to irrigate large and orchard land, especially to pump water from a tank (capacity of up to 15 lit.) to irrigate small plots like vegetables and seed beds with less physical effort.

Keywords: Reciprocating pump, Orchard and drainage line, large irrigation project areas, and Simple skills.

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INTRODUCTION

Everyone know that India has known for an agricultural based country approximately 75 % of population of India dependent on farming directly and indirectly and we know that our farmer using the same old methods and equipment. E.g. seed sowing, spraying, weeding etc. There is need for development of effective spraying. In the world of specialization of mechanization, it is essential to introduce new machine and techniques for the improvement and advancement of living standard of human being. A reciprocating pump is a mechanical device which converts mechanical energy into hydraulic energy and transfers same to the liquid through the pipe line thereby increasing the energy of the flowing liquid. Reciprocating pump is a positive displacement pump. It operates on a principle of actual displacement of pushing of liquid by a piston reciprocate in a cylinder. Here the reciprocating pump is mounted on a 'trolley' which supply the kinetic energy through the chain drive and pump convert into the hydraulic energy. On rear shaft of the 'trolley' and the piston rod both have free wheel (socket) which is attached trough chain drive. When a man drive the same man sprayed the liquid by sprayer. From this arrangement we are getting more efficiency of the man and machine and it reduces the more men power because a man who drive trolleys at same time he can spray the liquid.

II. MATERIALS AND METHODS

A. Existing Methods: The common techniques that the farmers are using, the traditional methods and same equipment from the past times. In our country, besides that there is large development of industrial and service sector as compared to that of agriculture, farming is done by traditional way.[1] The spraying is done by labor carrying backpack type sprayer. It requires more human effort.



Fig1 : Manual Backpack type sprayer

Hand operated rocker sprayer is also another technique that the farmers are using from the ages. The most commonly used sprayers are foot sprayer, knapsack sprayer, hand compression

sprayer, garden sprayer. Generally the capacity of all these sprayers is 9 liters.[4] All of these are used by the farmers from the very past times; these techniques are useful but consuming more efforts, more time with very less output. The technique that we have used here is the use of rotary motion into sprayer, thereby getting more output with less effort and consuming less time.

B. Reciprocating Pump Sprayer:

B.1 Materials with specification:

Selection of proper materials for the machine component is one of the most important steps in the process of machine design. The best materials are which will serve designed objective at minimum cost it is not always easy to select such a material and process may involve the trial and error method.

The following factors should be considered while selecting the material,

1. Availability
2. Cost
3. Mechanical property
4. Manufacturing consideration

Different components used:

1. Reciprocating Compressor

Cylinder:-

Total Volume of cylinder Without Piston

$$= \frac{\pi}{4} \times (4.8)^2 \times 12$$

$$= 217.14 \text{ cm}^3$$

Piston:-

Surface area of piston = $\pi \times d \times l$

$$= 11 \times 4.7 \times 4.1$$

$$= 60.53 \text{ cm}^2$$

Inner length of the cylinder when piston is arranged = Total length of cylinder — length of piston

$$= 12 - 4.1$$

$$= 7.9 \text{ cm}$$

$$\text{Swept Volume} = \Pi / 4 \times (d)^2 \times l$$

$$= \Pi / 4 \times (4.8)^2 \times 7.9$$

$$= 143 \text{ cm}^3$$

2. Pedestal Bearing:

The roller contact consist of four part inner and outer faces a rolling element like ball, roller or needle and cage with hold the rolling element together and space them evenly around the periphery.[2] Here we have used pedestal bearing.

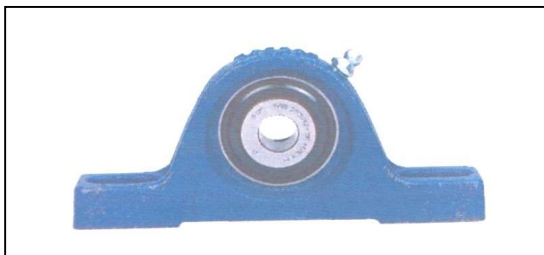


Fig 2: Pedestal Bearing

$$L = 17.5 \text{ cm } J = 12.5 \text{ cm } A = 8 \text{ cm } H = 9 \text{ cm } H' = 4.8 \text{ cm}$$

3. Chain:-

The Chain drives Consist of Outer Plates or Pin Link plates, inner plates or roller link plates, pin, bushes and roller. A pin passes through the bush which is secured in the holes of the roller between the two sides of the chain The Rollers are free to rotate on the bush which protects the sprocket wheel teeth against wear. [2] The pins, bushes and rollers are made of alloy steel a bush roller chain is extremely strong and simple in construction it gives good services under serve conditions there is little noise with this chain which is due to impact of the roller in the sprocket wheels teeth. This Chain may be used where there is little lubrication.

1) Distance between main sprocket and axle

= 60cm

2) Distance between axel sprocket to small free wheel = 17cm

3) Length Of the big chain = 164 cm

4) Length of the small chain

= $15.70 + 9.42 + (2 \times 17)$

= 59 cm

4. Nozzle

The spray angle does not hold for long spray distances. As illustrated in the figure below, the spray angle tends to collapse or diverge as you move away from the orifice.

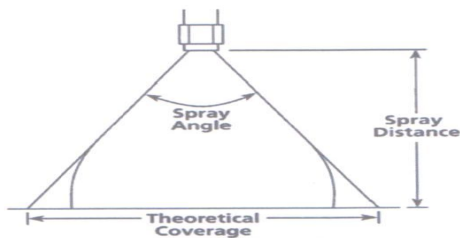


Fig 3: Nozzle Spray Angle

The theoretical coverage of spray patterns at various distances from the nozzle orifice is listed below. These values assume that the spray angle remains constant throughout the entire spray distance. The tabulated spray angles listed are approximate spray coverage using water. Spray distance varies with spray angle. Liquids more viscous than water form smaller spray angles, or solid streams, depending upon nozzle capacity, spray pressure, and viscosity. Liquids with surface tensions lower than water produce wider spray angles than those listed for water.

5. Spraying Rod



Length of Spraying rod = 86 cm

Length of normal Person hand = 72 cm

Total Length reaches by the sprayer

= 89+72

= 158 cm = 1.58 m

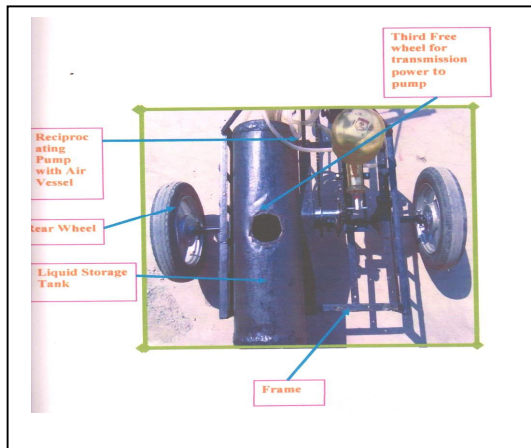


Fig 5: Main Parts and Description of Pedal Operated sprayer

B.2 working mechanism: A reciprocating pump essentially consists of a piston or plunger which moves to and fro in a closed fitting cylinder. A cylinder is connected to suction and delivery pipes, each of which is provided with non-return or one way valve called suction and delivery valve respectively. A function of non-return or one way valve is to admit liquid in one direction only. Thus the suction valve allows the liquid only to enter the cylinder and delivery valve permits only its discharge from the cylinder. The piston or the plunger is connected to a crank by means of a connecting rod. As the crank is rotated at uniform speed by a driving the paddle of trolley the piston or the plunger is connected to a freewheel by means of a connecting rod.

As the freewheel is rotated at uniform speed by a driving paddle or trolley the piston or plunger moves to and fro in the cylinder. When the freewheel rotate from $\theta = 0^\circ$ to $\theta = 180^\circ$. The piston or plunger which is initially at its extreme left position moves to its extreme right position. During the outward movement of the piston or plunger a partial vacuum is created in the cylinder, which enable the atmospheric pressure acting on the liquid surface in the well or sump below, to force the liquid up the suction pipe and fill the cylinder by forcing open the suction valve. Since during this operation of the pump, the liquid is sucked from below, it is known as suction stroke, thus at the end of the suction stroke, the piston or plunger is at its

extreme right position, the freewheel is at $\theta = 180^\circ$, the cylinder is full of liquid, the suction valve is closed and the delivery valve is just at the point of opening.

When the freewheel rotates from $\theta = 180^\circ$ to $\theta = 360^\circ$ the piston or plunger moves inwardly from its extreme right position towards left. The inward movement of the piston or plunger causes the pressure of the liquid in the cylinder to rise above atmospheric due to which the suction valve closes and the delivery valve opens. The liquid is then forced up the delivery pipe and raised to the required height since during this operation of the pump the liquid is actually delivered to the required height, it is known as its delivery stroke. At the end of the delivery stroke the piston or plunger is at extreme left position, the crank is at $\theta = 0^\circ$ to $\theta = 360^\circ$ (i.e. at its inner dead center) so that it has completed one full revolution, and both the suction and the delivery valves are close. This is in generating the working principle of reciprocating pump.

Fig 6 shows pedal operated reciprocating pump mounted on tricycle with two small rear wheels of car and one front wheel of bicycle.[3] The rotary motion of the pedal is transformed to rear wheels through chain. Simultaneously this motion is transferred to second free wheel to obtain reciprocating motion from rotary motion through second free wheel to collect liquid in pressure chamber with high pressure. Pressure chamber shall have a minimum volumetric capacity of 16 times of the piston displacement. When the piston rod travels to and fro motion the liquid from the water tank sucked and delivered through the sprayer with high pressure.



Fig 6: Full View of Tricycle with Pedal Operated Reciprocating Sprayer

III. CONCLUSION

This project is an effort to fulfill the entire requirement discussed earlier. The foot operated reciprocating pump is strictly designed taking into consideration all the mechanical term that are related to design of pump.

The foot operated reciprocating pump is mounted on trolley and that's why they can be transported easily. It is purely manually operated & not a bulky one. All the thing are aimed towards the less effort required to operate the pump.

The pump is a light duty component capable of sprayed high pressure liquid through nozzle.

It reduces man power for operation. The mechanisms that are complicated and costly to lubricate overall system hence it is strictly avoided in designing of pedal operated reciprocating pump.

Maximum quantity of liquid can be carried (up to 20 lit. depending on tank size) and also can be utilized. Develop about 80 to 90 psi. pressure. It can spray on tall trees with adjustable nozzle.

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