

DESIGN OF PNEUMATIC SPRAYING MACHINE AND DYNAMIC ANALYSIS

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Abstract:-

Many researchers are now eagerly working on renewable resources of energy to run routine life devices. In same way we are reworking on the daily use item of a farmer which is a spraying machine. Sprayer is a mechanical device used for the fumigation of pesticides to control disease, insects & weeds in the crops. Farmer have to negotiate with expensive fuel and electricity to run spraying machine. To break this barrier we have modified the spraying machine which contains a pneumatic cylinder piston, which utilize the compressed air to run the reciprocating pump. We are using the main benefit of air which provide energy when it is in compressed form. Our design includes the mechanization of sprayer by using double acting cylinder and reciprocating pump along with flywheel to escalate the pesticide spray without using any extravagant energy source. This mechanization is a kind of support to human operator so as to displace the muscular requirement of work. The good aesthetic design of this pneumatic sprayer ensure the efficient output in terms of discharge and pressure, their by encouraging the farmers to use renewable energy resource.

Keyword :- Double acting Cylinder Piston, Flywheel, Reciprocating pump, Renewableenergy Source.

INTRODUCTION

Sprayer is a mechanical device which contains the special mechanism to spray liquids with ease and effectiveness. Agriculture application of pesticide sprayer is concerned with the practical way of delivering pesticides (including herbicides, fungicides, insecticides, or nematode control agents) to their biological targets. One of the common form of sprayer used in traditional agriculture was the mechanical sprayer. The only drawback of this conventional sprayer lies in the continous effort required to push the liver up and down in order to create the spray pressure. Many types of sprayers are present now days with number of variants related to spray drop size, basic source of input energy to run it and pump type. In this present study our effort is to design a Pneumatic sprayer, so as to add a way to utilize air as a renewable source of energy in the research field. By keeping in to mind the spray inefficiency and our target to enhance the utilization of the renewable source of energy, we have developed a pneumatic spraying machine, which uses compressed air energy as a input source to the sprayer. This contribution in the field of environmentally friendly farming systems is done by incorporating simple mechanical devices to build a pneumatic spraying machine. For uniform and effective application of pneumatic sprayer, the various components like, double acting piston cylinder, reciprocating pump, flywheel, spraying nozzle and compressor are interlinked to each other with the help of special mechanism and all are attached on a portable frame to make it moveable easily.

USER STUDY

We have framed our user study on the basis of certain observations of pesticide spraying techniques used by farmers in remote areas by different type of sprayers. Farmers usually use two type of sprayers, one is manually operated and second one is electricity/fuel operated. Manual power operated sprayer's results in physical pain whereas fuel operated results in adding pollutants to our environment. Fuel/Electricity operated sprayers are very expensive and some time not available in remote areas. Pneumatic Spraying Machine is a refined design of manual operated spraying machine. Its portable and aesthetic design could efficiently meet the requirement of the farmers. The various parts selected for the development of this pneumatic spraying machine are simple in construction and are joined by simple mechanical links, which leads to correct & easy maintenance of this machine in the field by the operator himself. Secondly the compressed air assisted sprayer never lead to any kind of environment pollution.

LITERATURE SURVEY

Alamelu et. al. have worked on the spraying machine by utilizing a very cheap source of the renewable energy which is solar energy. Many times in some parts of the globe are not always having a sunshine due to heavy rainfall for some months etc. To tackle this kind of situations we have modified this with another renewable source of energy which is a compressed air. **Nagaraj et. al.** worked on flywheel to utilize energy from compressed air they have analyzed the work in the field of flywheel. For proper energy storage and energy transfer from a flywheel need appropriate mass and density. Being inspired from the new technology of using compressed air for running vehicles we have connected a special interlinked mechanism to connect the double acting cylinder piston with the reciprocating pump. After analyzing the research work of many researchers in the field of pesticides spraying technology, we have got an opportunity to develop a pneumatic spraying machine which leads to encourage the farmers to utilize the renewable resources thus preventing the environmental degradation due to fuel burning. **Dhanraj et. al.** have provided an aesthetic look to a developed spraying machine which utilizes the forces responsible for causing the motion of the spraying machine to spray the pesticide. However it is not possible to use the mechanism suggested by them to spray the pesticide during static stage. To overcome this problem we have added newness to the system, there by presenting our system with a new aesthetic look, to overcome the problem related to static stage of our machine.

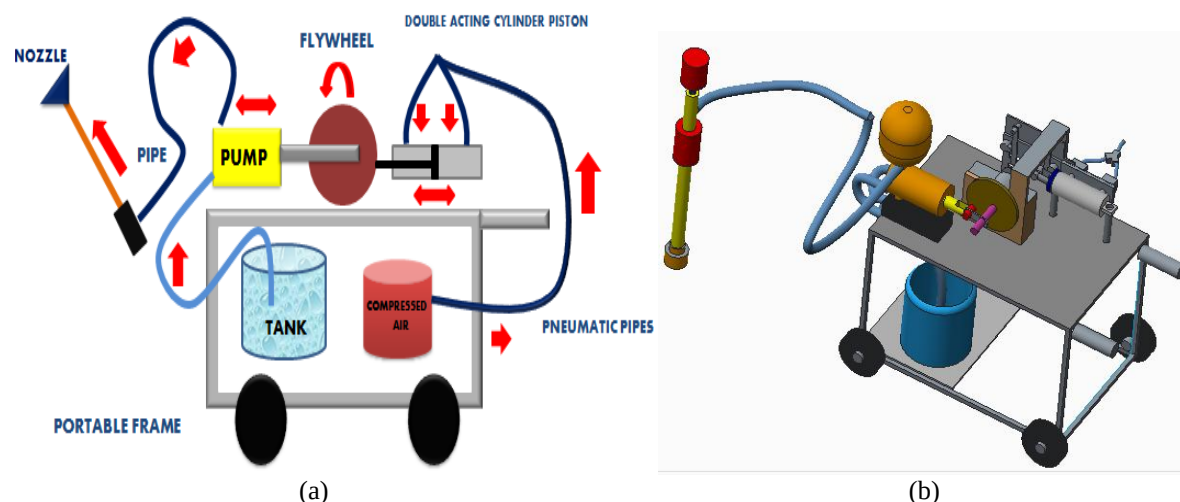


Figure:- 1 Basic Block Diagram of Pneumatic Spraying Machine in 2-D and 3-D

Working Methodology

It is quite simple as much as other spraying machines, but it runs on primary source which is a compressed air. It requires 200 psi threshold pressure to make it to perform its action in efficient way. Motion of the pump is indirectly initiated by double acting cylinder piston through a intermediate energy transferring source known as flywheel. When a primary input source of energy in form of compressed air is supplied to the double acting cylinder piston which is actually providing motion by expanding in cylinder piston. To control the motion of double acting cylinder piston we requires a special setup which controls the flow of the compressed air supplied by cylinder. When compressed air is in way to enter in the double acting cylinder piston a Y-joint leads to divide the compressed air in two paths which are actually supplying the compressed air to both the ports of double acting cylinder piston. Strip with a holes in it is controlling and deciding the inlet and outlet ports. Strip is continuously changing backside port as inlet port and frontend port as outlet port and vice-versa. Aluminum block with a guiding hole in it are developed in such a way to avoid any blockage of compressed air while going into cylinder piston and coming out of the cylinder piston. Once the compressed air is starts moving the double acting cylinder piston it starts to reciprocate the rod of piston will lead to accelerate the flywheel with a simple connection of nut and bolts. While the motion of the connecting rod of double acting cylinder piston providing that much force to rotate the flywheel that same time it also going to manage the motion of strip to control the both ports state that which lead to enter the compressed air and which will lead to exit it out of cylinder according to movement of double acting cylinder piston. This whole mechanism of links convert it into a automatic system which only requires compressed air to run the flywheel. Our projects contain its major part a reciprocating pump with complete setup of the fine spray nozzle and water supplying pipes. Plunger of the reciprocating pump is directly attached to the flywheel with the help of nut and bolts is going to start reciprocating when flywheels starts to rotate. Once the plunger moves inside the pump it will starts spraying pesticide through fine spraying nozzle by covering all area properly.

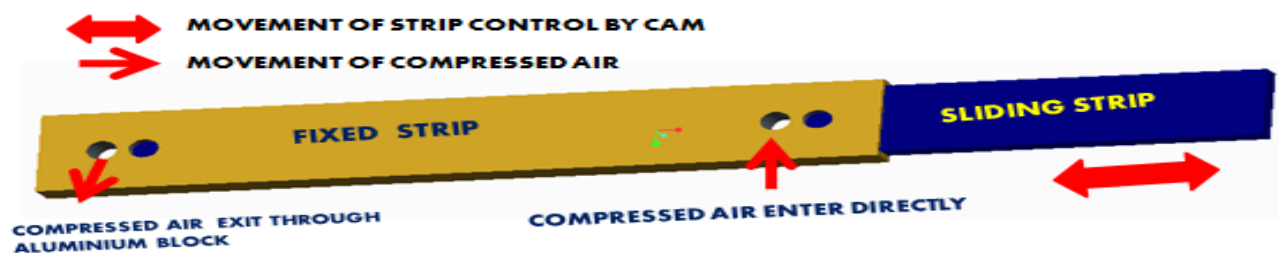


Figure:-2 Motion Of Strip To Control Entry and Exit of Compressed Air In Double Acting Cylinder Piston

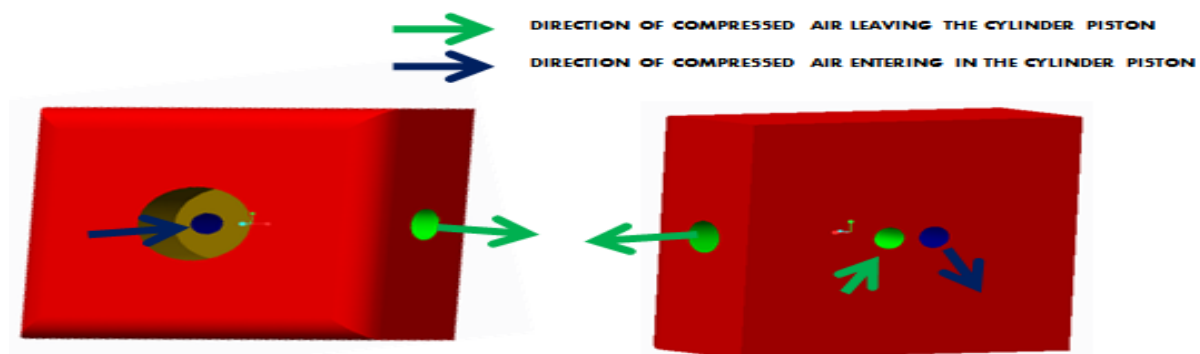


Figure:-3 Working Of Special Designed Aluminum Blocks

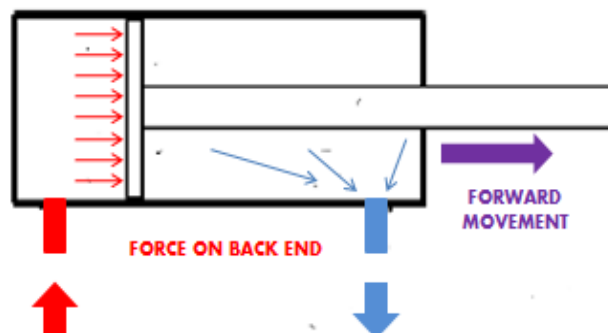


Figure 4:- Forward Movements Of Piston Rod

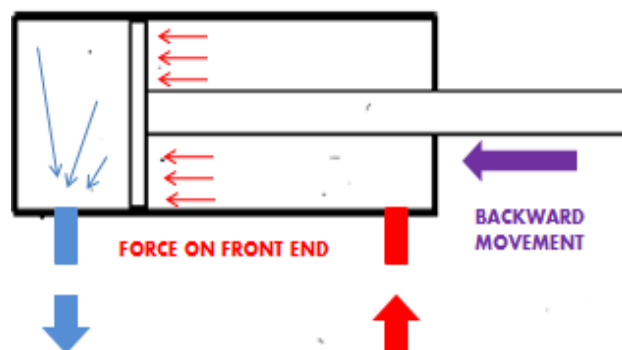


Figure 5:- Backward Movements Of Piston Rod

Experimental Setup

In Pneumatic spraying machine setup main motto is to run a spraying machine with compressed air. In our experimental setup we are having main mechanical devices listed as:

Double Acting Piston
Flywheel
Reciprocating Pump
Strip Mechanism

Reciprocating Pump is a mechanical component which contain a plunger to reciprocate inside a specified bore diameter cylinder. When Plunger move backward it act as a suction stroke to fill liquid in it and in another forward movement it act as a spraying stroke. This continuous movement of plunger with some mechanical actions lead to spray the pesticide to escalate all around the specified area.

2] Flywheel is mechanical device which cache the energy which is utilize to provide motion to the different devices which are attached to it. Energy storing capacity of the depends upon density and mass of the flywheel.

3] Double Acting Cylinder Piston is mechanical device which utilize the energy from fluid(Pneumatic and hydraulic type) to reciprocate the internal rod inside the cylinder. In type of the cylinder piston both the forward

and backward type of motion is controlled by the fluids only. Fluid guide piston motion by entering from one port and leaving the another port and it act vice versa after every single side motion.

4] Strip mechanism is act as a spinal code of are project it transfer the complete motion from double acting cylinder to the pump with help of the inter connected joints. Strip motion is actually guided by the flywheel energy. Once the flywheel starts rotating it continuously going to provide sufficient energy to the link welded on the rod of double acting cylinder piston. Rotary motion of the flywheel will going to provide similar motion to the link connected to on other side. This link act as a cam which lead to operate the strip motion to control the entry and exit of the compressed in the double acting cylinder piston.



Figure 6:- Experimental Setup

Calculations

Data available

Stroke Length of Double Acting Cylinder Piston (S_{Piston}) = 80 mm = 0.08 m

Bore Size of Double Acting Cylinder Piston ($D_{\text{Bore Piston}}$) = 25 mm = 0.025 m

Diameter of Rod of Piston ($D_{\text{Rod Piston}}$) = 12 mm = 0.012 m

Stroke Length of Reciprocating Pump (S_{Pump}) = 80 mm = 0.08 m

Bore of Pump (D_{Pump}) = 50 mm = 0.050 m

Pressure of Compressed Air Supplied = 200 psi = 1378951.46 Pa

Data observed

RPM of Flywheel observed = 92 rpm

$$\begin{aligned} \text{Force on Piston From Back Side Port (} F_{\text{BackPiston}} \text{)} &= \text{Pressure X Area Back Port} \\ &= 1378951.46 \times \left(\frac{\pi}{4} \right) \times (D_{\text{Bore Piston}})^2 \\ &= 1378951.46 \times 4.9 \times 10^{-2} \\ &= 675.6862 \text{ N} \end{aligned}$$

$$\begin{aligned} \text{Force on Piston From Front Side Port (} F_{\text{BackPiston}} \text{)} &= \text{Pressure X Area Front Port} \\ &= 1378951.46 \times (\pi/4) \times [(D_{\text{Bore Piston}})^2 - (D_{\text{Rod Piston}})^2] \\ &= 1378951.46 \times 3.77 \times 10^{-4} \\ &= 519.8617 \text{ N} \end{aligned}$$

$$\begin{aligned} \text{Volume of Pump} &= (\text{Area of Bore of Pump}) \times (S_{\text{Pump}}) \\ &= [(\pi/4) \times (D_{\text{Pump}})^2] \times 0.080 \\ &= 1.96 \times 10^{-3} \times 0.080 \\ &= 1.57 \times 10^{-4} \text{ m}^3 \end{aligned}$$

$$\text{Volume of Water Sprayed in 2 Revolutions of Flywheel} = \text{Volume of Pump}$$

$$\text{Volume of Water Sprayed in 1 Revolutions of Flywheel} = (\text{Volume of Pump}) / 2$$

$$\begin{aligned} \text{Volume of Water Sprayed in 92 Revolutions of Flywheel} &= [(1.57 \times 10^{-4}) / 2] \times (92) \\ &= 72.22 \times 10^{-4} \text{ m}^3 \end{aligned}$$

RESULT

Volume of Water Sprayed in 1 minute = 7.2 litre

Volume of Water Sprayed in 1 hour = 432 litre

PRESSURE OF COMPRESSED AIR (PSI)	RPM of FLYWHEEL (RPM)	FORCE ON FRONT END OF PISTON ROD (N)	FORCE ON BACK END OF PISTON ROD (N)	VOL. OF WATER SPRAYED IN 1 HOUR (liters)
200	92	519.8617	675.6862	432
225	96	584.847	760.146	452
250	101	649.830	844.607	475
275	115	714.813	929.068	541
300	120	779.797	1013.529	565

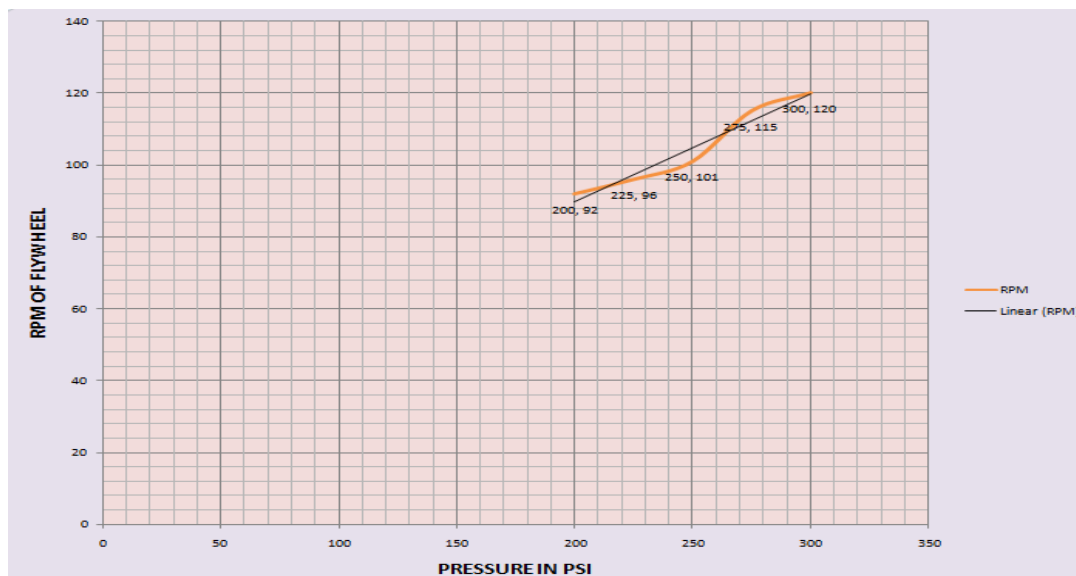


Figure 7:- Result of Pressure of compresses air with RPM of flywheel

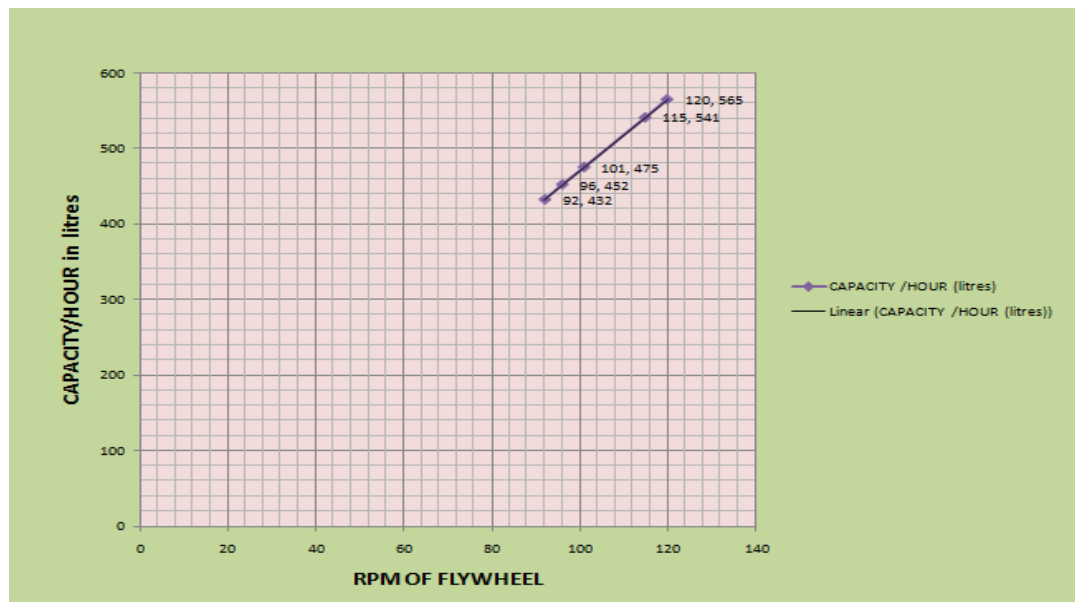


Figure 8:- Results of volume of water sprayed with the RPM of flywheel

Conclusion

The proposed pneumatic sprayer gives the average values as efficient output in all aspects like weight, discharge, pressure and cost. It requires 200 pounds threshold pressure to give it initials movement. It reduces the discomfort to the operator while spraying and it creates the awareness about renewable energy to the farmers. This pneumatic spraying system has got very good aesthetic design and the operator feel easy to operate this new sprayer because of it is easy to carry, portable and environmental friendly. For small and medium scale farmers and remote areas like field, forest where fuel is not available easily, the proposed pneumatic sprayer is most suitable device to spray their crops in very efficient way in terms of cost, use of renewable source of energy.

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