Design Analysis & Performance evaluation of Agriculture sprayer and fertilizer dispenser

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Abstract **- Combination of Agriculture operations in a single machine can bring about considerable cost reduction, and reduce the time and effort required in the extremely labor-intensive agriculture work and offer solution to the problems of shortage of labor and expensive agriculture operations. The pesticide spraying and fertilizer dispensing are above mentioned agriculture operations prominently done manually. The pesticide spraying is done using a back mounted spray pump whereas the fertilizer dispensing is done using hands.**

Combination of the above two operations is done with the view to reduce considerable man hours and efforts and make them considerable economical. The paper discusses the design and analysis of the critical components of the machine. The drive train gear pair, connecting rod and connecting pins are identified parts. The paper also elaborates on the test and trial conducted on the machine and thus the performance characteristics of the machine.

Index Terms **- Agriculture sprayer, fertilizer dispenser, pesticide, economic, ergonomic.**

1.INTRODUCTION

The proposed machine combines the operation of spraying of pesticide and spraying of the fertilizer. The spraying is done by use of a reciprocating pump of 3 litre capacity. The drive mechanism of the sprayer pump is extracted from the rear wheel shaft of the vehicle whereas for the fertilizer sprayer the 12-volt dc motor is used. The motor is used as the prime mover for moving the spinner shaft on the spinner disk is mounted that sprays the fertilizer.

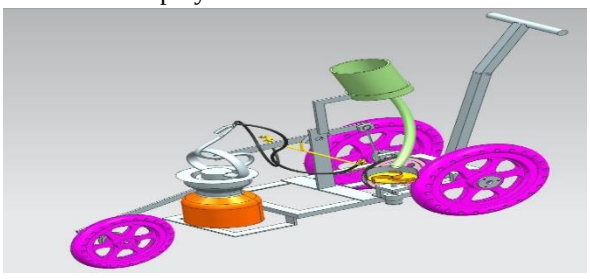
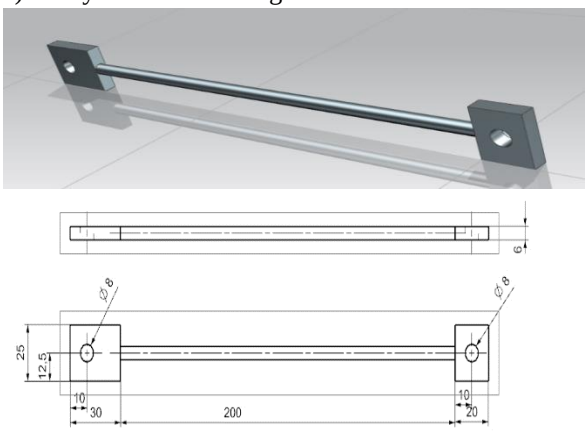


Figure: Pesticide sprayer with fertilizer dispenser

Design and Analysis of components:

a) Analysis of Connecting rod:



Material: C45

Theoretical pull force = 324 N

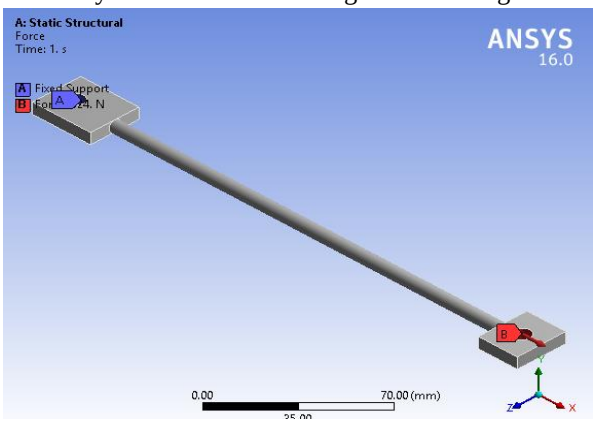
a) Considering pure tension load;

Ft = Load / Area = 324 /Π *d^2

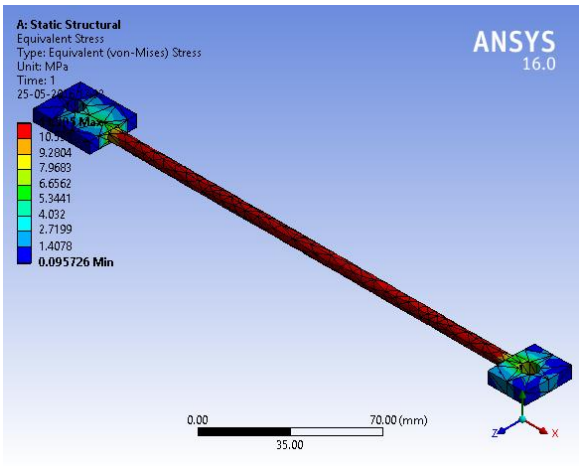
Maximum tensile stress (ft) = 6.44 Mpa

Analysis of Connecting rod

Boundary conditions and loading of connecting rod

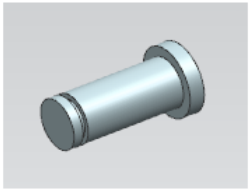


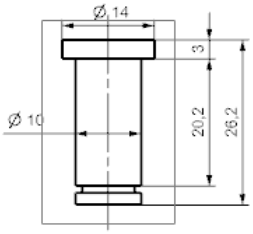
Maximum stress in connecting rod



As the maximum stress induced in the conncecting rod is 11.9 n/mm2 < allowable stress shows that the crank-1 is safe under given system of forces.

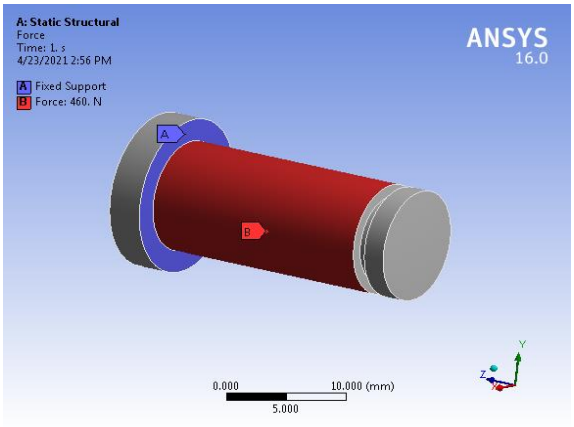
b)Analysis of coupler pin :





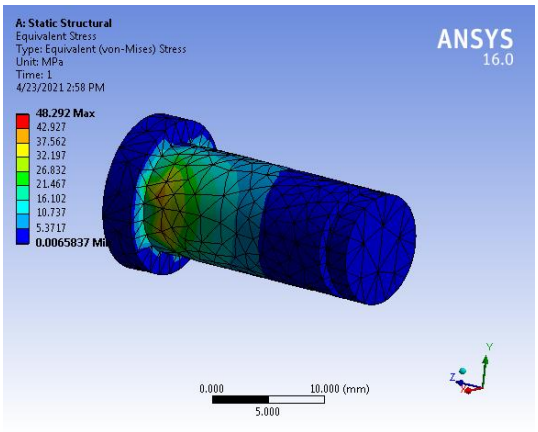
Material: EN9
Maximum force = 920 N-
a) Considering double shear load;
fs = F/ (πx10^2/4)
Maximum shear stress (th) fs = 11.7 Mpa

Analysis of coupler pin



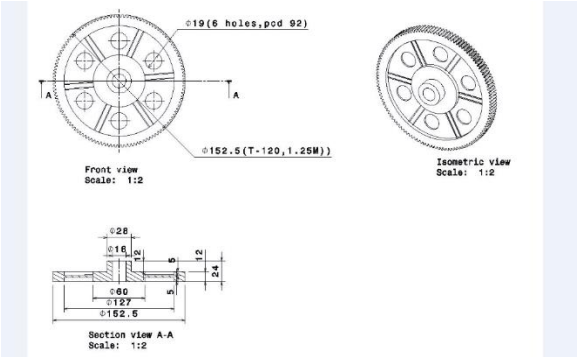
Boundary conditions and loading of crank

Maximum stress in coupler pin



The maximum stress induced in the coupler pin is 40 Mpa by analytical method

2.DESIGN OF SPUR PINION & GEAR FOR DRIVE FROM INPUT SHAFT TO CRANK



Stage 1: Drive as GEAR and pinion arangement
Maximum load =Maximium torque / Radius of gear
No of teeth on gear = 120
No of teeth on pinion = 60
Module = 1.275mm
Load=200 N
b = 10 m
Material of spur gear and pinion = Nylon-66
Sult pinion = Sult gear= 300 N/mm^2
Service factor (Cs) = 1.5
The gear and pinion arrangement whereas pinion has 60 teeth and gear has 120 teeth share the entire tooth load…
Pt =(W x Cs) = 200 x 1.5 = 300 N.
Peff = 300 N (as Cv =1 due to low speed of operation)
Peff = 300 N --------(A)

Lewis Strength equation
WT = Sbym

Where ;
Y= 0.484 – 2.86 Z
yp = 0.484 - 2.86 = 0.44/60
Syp = 34.91

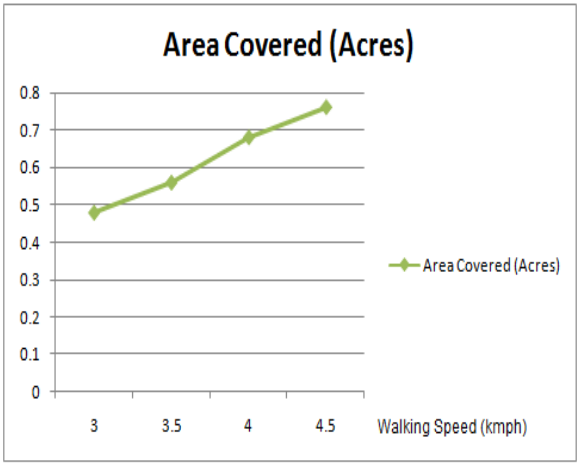
As Syp < Sys ⇒ pinion is weaker
W_T = (Syp) x b x m
=34.91 x 10m x m

W_T= 349.1 m^2----------(B)
Equation (A) & (B)
349 m^2 =300
m=0.93mm
selecting standard module =1. 275mm or ease of construction as we go for single stage gear box making size compact achieving maximum strength and proper mesh.

Test and trial on Agriculture Sprayer Mechanism
Results for Sprayer mechanism:

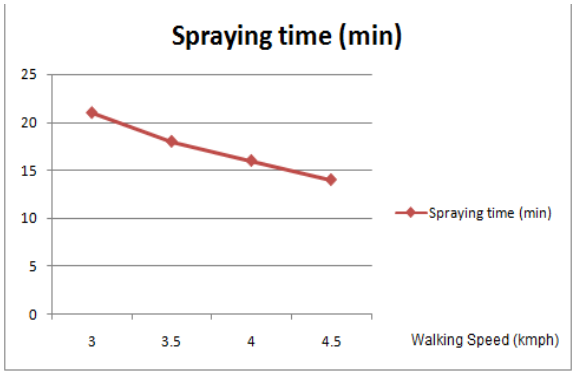
Sr. No	Walking Speed	Area covered / tank	Time
01	3kmph	0.48 acres	21 min
02	3.5 kmph	0.56 acres	18 min
03	4 kmph	0.68 acres	16min
04	4.5 kmph	0.76 acres	14 min

Graph of Area Covered by sprayer Vs Walking speed



The area covered by the sprayer is seen to increase with the increase in walking speed and coverage of more area is also accounted to increase in pumping pressure that increases very small droplets and thus lesser pesticide usage as compared to low walking speed of the vehicle.

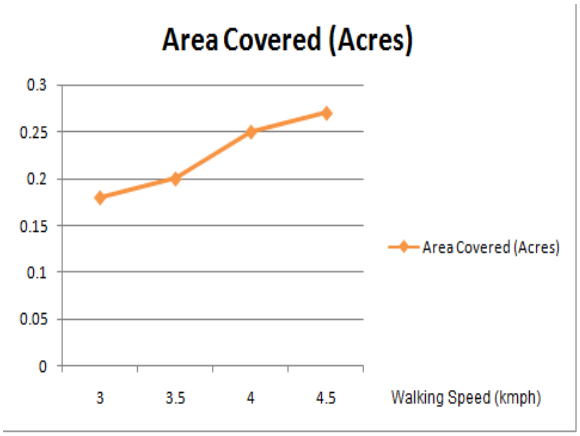
Graph of Time of spraying Vs Walking speed



The time of spraying by the sprayer decreases with the increase in walking speed , this is as an effect of more spraying pressure and larger area covered as a result of fast walking speed

Results for Fertilizer dispensing mechanism:

Sr. No	Walking Speed	Area covered / tank
01	3kmph	0.18 acres
02	3.5 kmph	0.20 acres
03	4 kmph	0.25 acres
04	4.5 kmph	0.27 acres



The area covered by the fertilizer dispenser increases with the increase in walking speed as more spread area in lesser fertilizer consumption as compared to low walking speed.

ADVANTAGES

- Pump mounted on vehicle
- Automated Pumping
- Compact size
- Low Cost
- . Low maintenance
- More area coverage

DISADVANTAGES

- Presently only 5 –litre capacity.
- Not Suitable for very close gap crop

3.CONCLUSION

Various types of sprayers and devices are available for spraying of pesticide. Similarly, the fertilizer dispensing is done manually or through the attachment to tractors It is also observed that the operations are done individually although the combination device is not studied or fabricated. Combination of both operations in one vehicle will reduce the cost of operation and will be beneficial to the farmer. The critical components of the system namely the wheel shaft, crank, dispenser shaft was checked by theoretical as well as analytical method and the parts were found to be safe. The manufacturing of the combination system has been done by suitable methods. The assembly of the components has been done and the testing has been done to determine the performance of the sprayer and fertilizer dispenser mechanism The area covered by the sprayer is seen to increase with the increase in walking speed and coverage of more area is also accounted to increase in pumping pressure that increases very small droplets and thus lesser pesticide usage as compared to low walking speed of the vehicle. The time of spraying by the sprayer decreases with the increase in walking speed, this is as an effect of more spraying pressure and larger area covered as a result of fast walking speed.

The area covered by the fertilizer dispenser increases with the increase in walking speed as more spread area in lesser fertilizer consumption as compared to low walking speed.

4.FUTURE SCOPE

The system can be made solar operated through application of solar panel and storage battery. Similarly, the fertilizer sprayer can be installed on two sides of the machine to get coverage on both sides of the row.

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