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Design and Fabrication of Multipurpose Hybrid Sprayer

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Abstract: ***The population of India is increasing rapidly, in order to fulfil their diet & needs, the production of foods must be increased. In India farming is done by traditional ways beside that there has been larger development of industry as service sector as compared to that of agriculture sector.***
To mechanize of agriculture in India some equipment have been developed. In agriculture, spraying of pesticide is an important task to protect the crops from insects, for obtaining high yield. However, farmers have been mainly using traditional conventional techniques like hand operated and fuel operated spray pump system for spraying pesticides.
Now a days the concept and technology of employing non-conventional energy has become very popular for all the development activities. With this motivation, a sincere attempt has been made to develop a Multipurpose Hybrid Sprayer, the sprayer was designed considering parameters like desired spraying efficiency, user-friendly, low operating time and for faster coverage of area. Thus, the sprayer was designed to be a value for money product in the agriculture sector.

I. INTRODUCTION

Agriculture Scenario in India: India's economic security continues to predicate upon the agriculture sector, and the situation is not likely to change in the future. Even now agriculture supports 58% of the population, as against about 75% at the time of independence. As of today, India supports 16.8% of world's population on 4.2% of world's water resources and 2.3% of global land. The country recorded impressive achievements in agriculture during three decades since the onset of green revolution in late sixties. This enabled the country to overcome widespread hunger and starvation; achieve self-sufficiency in food; reduce poverty and bring economic transformation in millions of rural families.

The situation, however, started turning adverse for the sector around mid-nineties, with slowdown in growth rate of output, which then resulted in stagnation or even decline in farmer's income leading to agrarian distress, which is spreading and turning more and more serious. Natural resource is the base of agriculture, which provides for sustainable production, is shrinking and degrading, and is adversely affecting production capacity of the ecosystem.

However, demand for agriculture is rising rapidly with increase in population and per caput income and growing demand from industry sector. There is, thus, an urgent need to identify severity of problem confronting agriculture sector to restore its vitality and put it back on higher growth trajectory.

The problems, however, are surmountable, particularly when new tools of science and technology have started offering tremendous opportunities for application in agriculture. The Equipment Our equipment is especially made to work in row crops such as cotton pulses etc. of an agricultural field. The economic condition of farmers and the cost of labor, owing to such conditions, this equipment can find its application.

The equipment is intended to perform three important operations done in fields, namely, Spraying pesticide, spraying herbicide and applying urea. All the three operations can be performed simultaneously or individually. Application of urea to the crops is not being focused much by various agriculture equipment producing firm and the equipment available are mostly suitable for large field which are in hectors.

Moreover, whatever methods are available for applying urea results in high wastage of urea, we have focused on the same. Sprayers are fully integrated, mechanical systems, meaning they are composed of various parts and components that work together to achieve the desired effect, in this case: the projection of the spray fluid.

This can be as simple as a hand sprayer attached to a bottle that is pumped and primed by a spring-lever, tube, and vacuum-pressure; or as complex as a 150 feet reach boom sprayer with a list of system components that work together to deliver the spray fluid. For more complex sprayers, such as agricultural sprayers, common system components include: the spray nozzle, sometimes with a spray gun, fluid tank, sprayer pump, pressure regulators, valves and gaskets, and fluid plumbing.

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The sprayer pump can be just as important as the sprayer type itself as there are many sprayer pump design types with various construction materials, inlet/outlet sizes, and performance specifications. Common sprayer pump types include diaphragm, centrifugal, and roller pump.

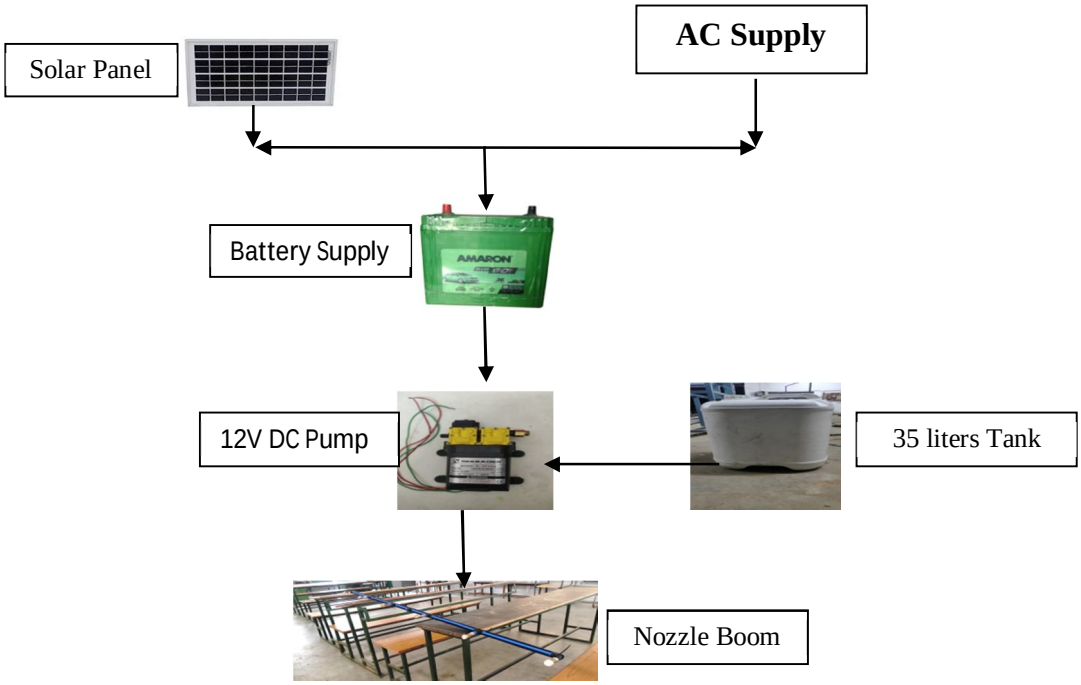
II. LITERATURE SURVEY

1) *International Research Journal of Engineering and Technology:* Automation for spraying in the field of agriculture has increased the productive output of the farms. Owing to this, labor problem has been solved. But the scenario in the country like India is different. The agriculture field being small, automation is such places are a difficult task also the economic condition of majority of Indian farmers is not well to do. India's economic security continues to predicate upon the agriculture sector, and the situation is not likely to change in the future.
2) *Shivaraja Kumar Parameswaramurthys paper on Design and Development of wheel and pedal Operated Sprayer:* It is a portable device and no need of any fuel to operate, which is easy to move and sprays the pesticide by moving the wheel and also peddling the equipment.
3) *Sandeep H. Poratkar, Dhanraj R. Raut,"Development of Multinozzle Pesticides Sprayer Pump":* This paper suggests a model of manually operated multi nozzle pesticides sprayer pump which will perform spraying at maximum rate in minimum time. Constant flow valves can be applied at nozzle to have uniform nozzle pressure.
4) *"ShaileshMalonde et al "Design and Development of Multipurpose Pesticides Spraying Machine" IJAEGT Volume 04":* As India is agriculture based country and 70% people do farming and related work.Agriculture is required to be boomed to enhance the Gross Domestic Product (GDP) of thecountry by improving the productivity. The productivity of the crops can be increased withthe help of pest control. Pesticide spraying is the necessary procedure in cultivation of thecrops. The present idea deals with the designing and fabricating a pesticide sprayer whichwill be useful and affordable to the farmers which will assist to increase the productivity ofcrops. Though this project an attempt has been done to improve the method of spraying thepesticide that will enhance the productivity and increase the farmer's income. So we havedesigned a pesticide spraying machine which will not only increase productivity but also willreduce the effort of the farmers.The machine will save the time of the farmer as well asefficiency in spraying. This model carries multi nozzle pesticides sprayer pump which willperform spraying at maximum rate in minimum time. Constant flow valves can be applied at nozzle to have uniform nozzle pressure.
5) *"Pandurang Lad et al "Solar Operated Pesticide Sprayer" IJARSE Volume 04":* A Solar Operated Pesticide Sprayer is a pump running on electricity generated byphotovoltaic panels or the thermal energy available from collected sunlight as opposed togrid electricity or diesel run water pumps. The operation of solar powered pumps is moreeconomical mainly due to the lower operation and maintenance costs and has lessenvironmental impact than pumps powered by an internal combustion engine (ICE). Solarpumps are useful where grid electricity is unavailable and alternative sources (in particularwind) do not provide sufficient energy. The solar panels make up most (up to 80%) of thesystems cost. The size of the PV-system is directly dependent on the size of the pump, theamount of water that is required and the solar irradiance available. The solar sprayer hasmany advantages. Besides reducing the cost of spraying, there is a saving on fuel/petrol.

III. LITERATURE REVIEW

The Food and Agriculture Organization (FAO) has defined pesticide as: Any substance or mixture of substances intended for preventing, destroying, or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals, causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances that may be administered to animals for the control of insects, arachnids, or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant, or agent for thinning fruit or preventing the premature fall of fruit. Also used as substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport

IV. METHODOLOGY



V. DESIGN AND CALCULATION

A. Power Generated By Solar Panel

Voltage at maximum power= 12v
Current at maximum power= 0.833A
∴ We know the equation of power
P= V*I
12*0.833= 9.99 ≈ 10W
Power generated by the solar panel is 10W

B. Time Required To Charge The Battery

We have the formula

$$T = \frac{Battery\ capacity\ in\ Ah}{Current\ supplied\ by\ the\ solar\ pannel}$$

Battery capacity= 18Ah
Current at max power= 0.833A
T= 18/0.833
T= 21.6hrs
Total time required to charge the battery by Solar panel is **21.6hrs**

C. Time of Spray (Time to Discharge)

$$t = \frac{Battery\ capacity\ in\ Ah}{Current\ drawn\ by\ motor}$$

Battery capacity= 18Ah
Current drawn= 4A
t= 18/4
t= 4.5hrs
Total time to discharge pesticide by battery power is 4.5hrs

D. Flow Rate

1) Head

Pump pressure= 100PSI

1PSI= 6894 Pa

100PSI= 6894*10^2 Pa.

We have P= ∫gh.

P= 6894*10^2

g= 9.81ms^2

h= $\frac{6894*10^2}{1000*9.81}$

h= 70.23≈ 70m

2) Actual flow Rate

We have equation

Q_{act}= $\frac{Capacity\ of\ tank\ in\ ltr}{Time\ required\ to\ empty\ the\ tank}$

Capacity of the tank= 35lts.

Time required to empty the tank= 8min 50sec.

Q_{act}= $\frac{35}{530}$

Q_{act}= 3.96lt/min

Actual Flow rate of 6 nozzle in **3.96lt/min**

3) Actual Flow Rate For Each Nozzle Is

3.96/6= 0.66m^3/min/nozzle

E. Volumetric Efficiency

For volumetric efficiency we have equation

ηvol= Q_{act}*100

ηvol= 0.66*100= 66%

The volumetric efficiency of sprayer is 66%

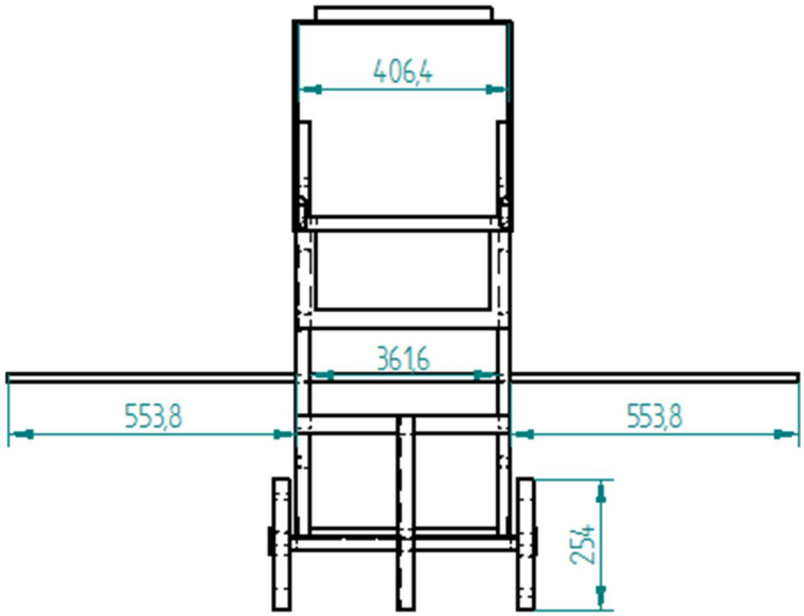


Figure 6.1: 2-D front View of operational setup

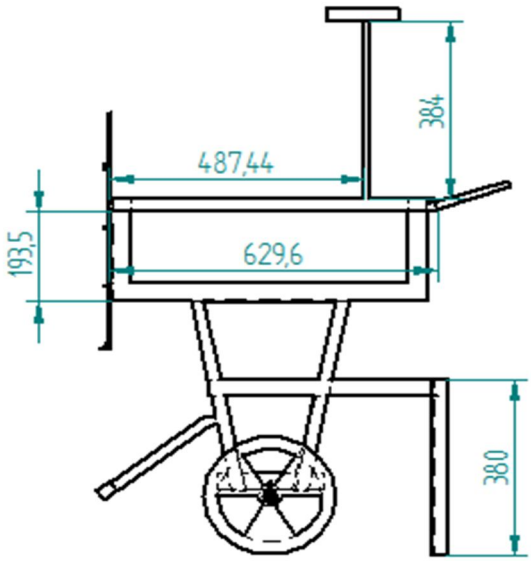
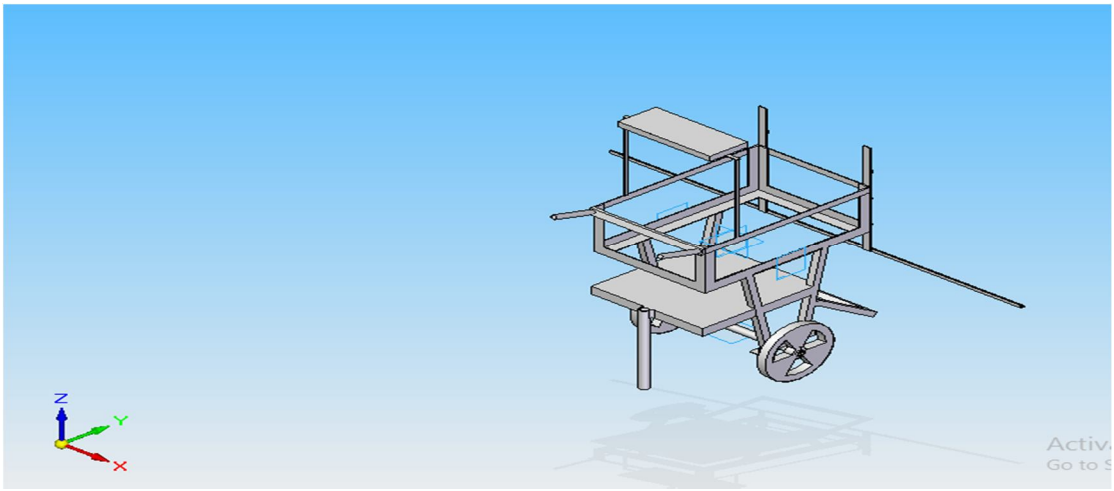
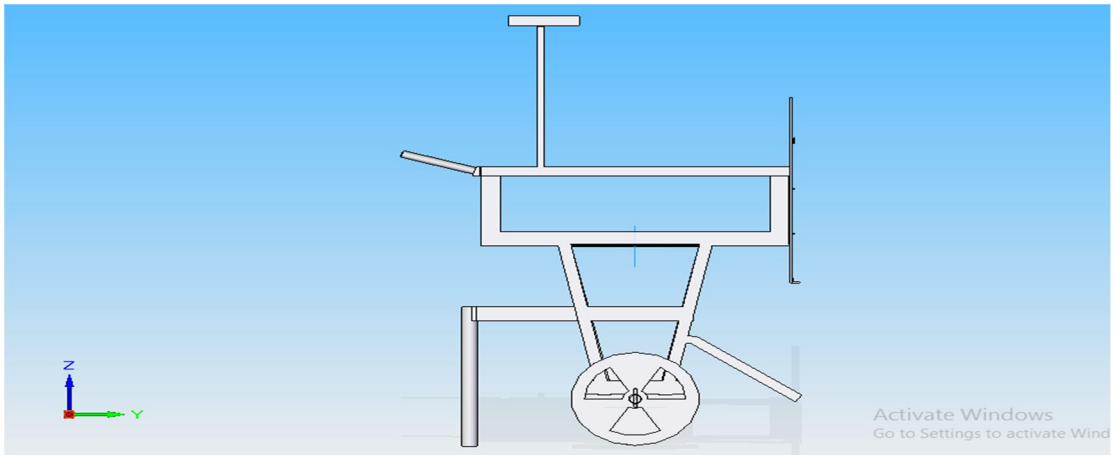


Figure 6.2: 2-D side View of setup (All dimensions are in mm)

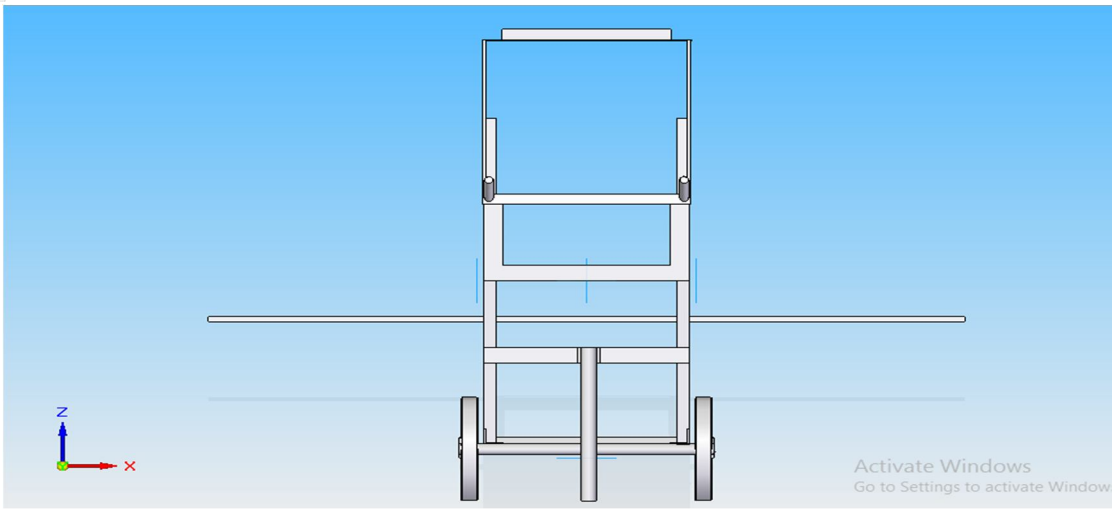
F. 3D Cad Models



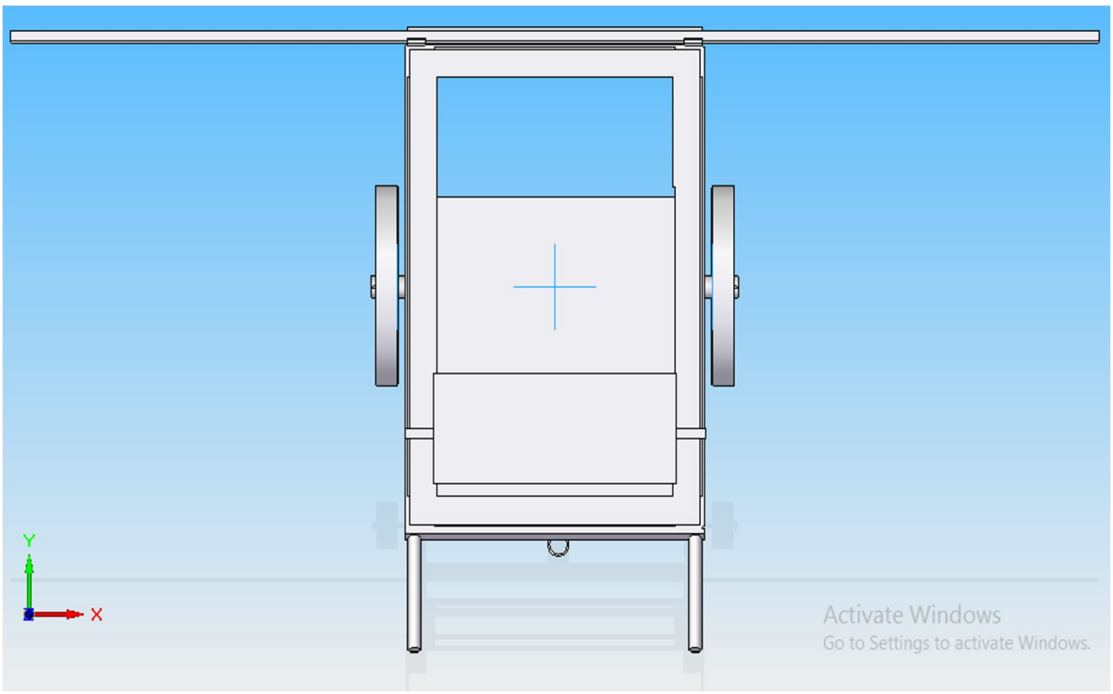
3-D Isometric view



3-D Side view



3-D Front view



3-D Top view

VI. ADVANTAGES AND APPLICATION

A. *Advantages*

1) There is minimum running cost associated with the sprayer.
2) No requirement of skilled operator.
3) The sprayer is very economical in case of mass manufacture of the entire unit.
4) The flow rate calculation demonstrates the optimization of output flow rate of pesticide within time constrains which reduces the wastage of pesticide.
5) The sprayer prevents biological hazards of spraying powder pesticide by means of conventional methods.
6) Micronutrients can also be sprayed with this unit.
7) The sprayer is economical.
8) It is easy to handle, clean and maintenance.
9) Solar energy can also be used for charging the battery.

B. Applications

1) Widely used in Horticultural crops like citrus fruits, Dry fruits etc.
2) It is used to spray weedicides to control the weed growth in field.
3) Sprayer can be used in lawn for domestic purpose.
4) It can widely used for gardening.
5) This sprayer can be used in nurseries.

VII. MODEL IMAGES

Final Image Of Multipurpose Hybrid Sprayer

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VIII. RESULTS AND DISCUSSION

The results obtained after testing the solar powered spray pump system are as follows:

The characteristic of battery voltage and fluid discharge wrt time as shown in theFig.9.1. indicated the battery was continuously drawing the current through the charge controller from the solar panel as there was a demand from the motor to operate the pump.

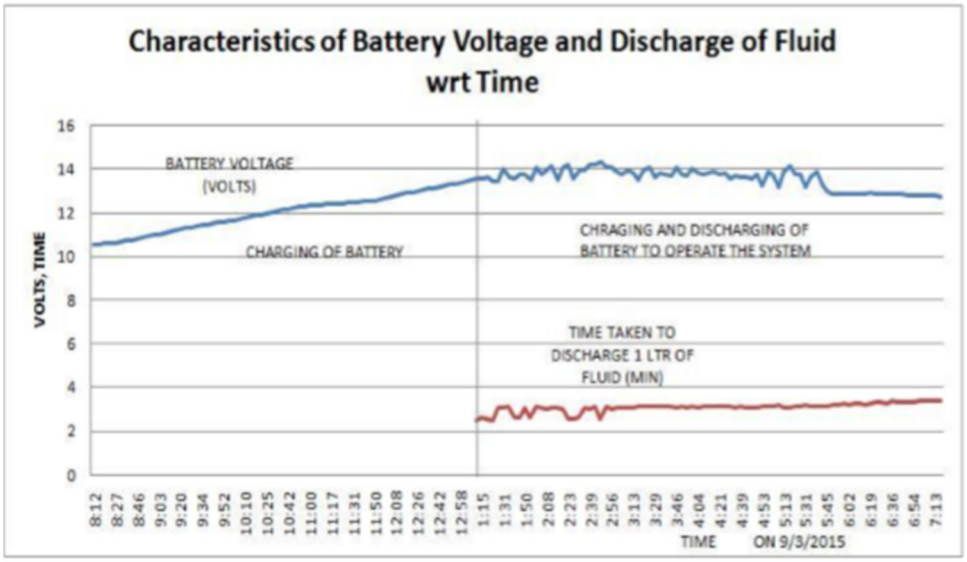

Figure 9.1**:** Characteristics of Battery voltage and Fluid

A. Discharge with respect to Time

1) The solar powered spray pump system worked for 6 hrs.
2) The battery had 12.74 V indicating it had not been completely discharged.
3) The fluid discharge of our system is 3.96 ltr/min.
4) The time taken to empty the 35ltr tank by nozzles is 58min 50sec.
5) The weight of the system is 44.1kg and maximum weight of the system by considering fluid is 81.1kg.
6) Fine droplets of atomized particles were obtained.

B. Rate of Spray

Quantity in liter	Time in sec	Flow rate in liter/min
25	4min 25sec	1.98
35	8min 50sec	3.96

Table 9.1: Rate of Spray

IX. CONCLUSION AND FUTURE SCOPE

A. Conclusion

The fabricated Multipurpose Hybrid Sprayer is suitable for agricultural purpose. It is simple but very effective and is user friendly. The sprayer is easy to port and can be effectively used in places where there is fuel and power are not available. As Multipurpose Hybrid Sprayer is economical compared to conventional engine operated sprayers.

B. Future Scope

1) By adopting Hydraulic system to wheels, the Ground clearance can be easily adjusted.
2) By incorporating sensors the sprayer system can be automated.
3) By adopting adjustable width of frame, the versatility of sprayer can be enhanced and can be used for all crops.
4) By providing ergonomical seating arrangements, the sprayer is more comfortable to use.

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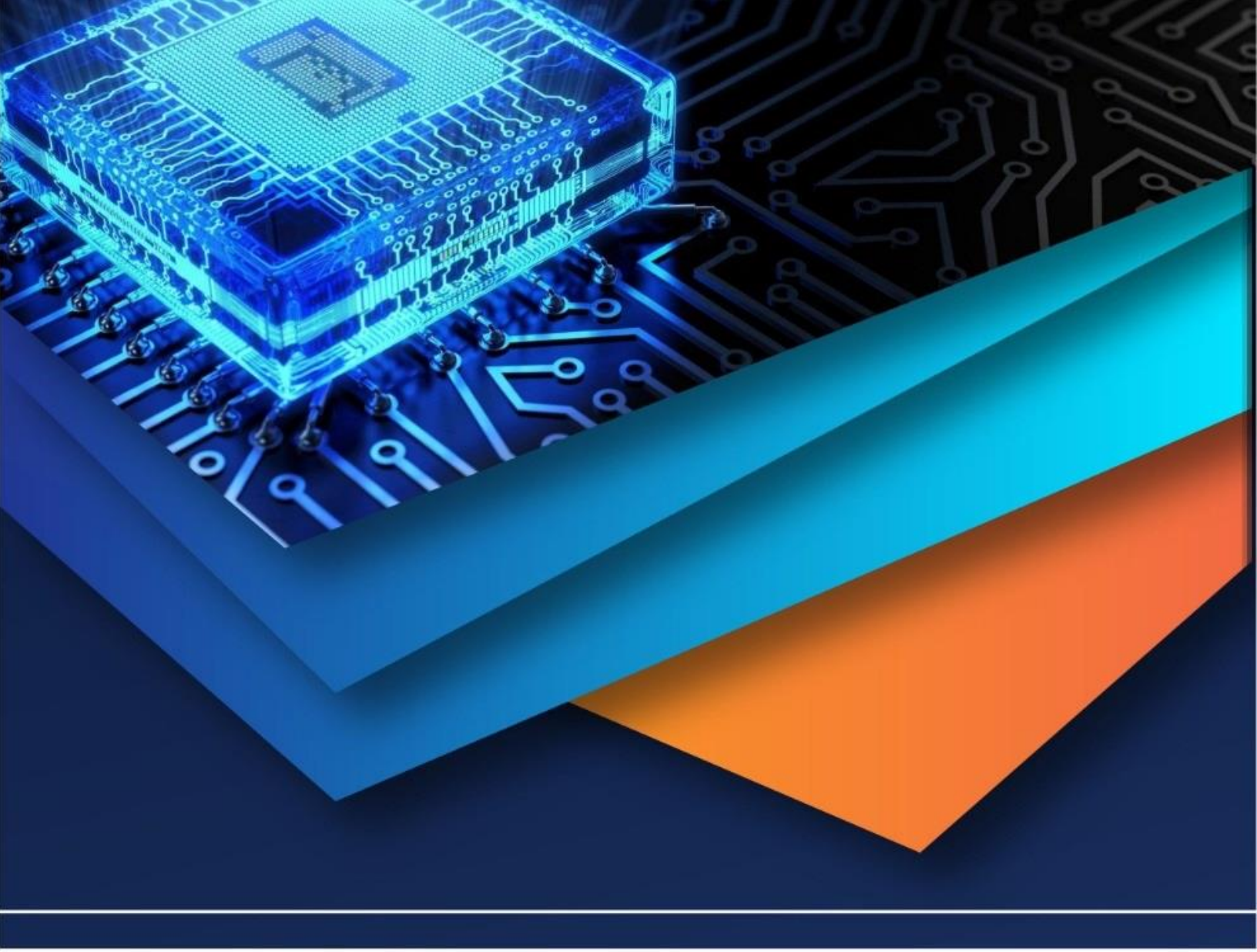

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