iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VIII **Month of publication:** August 2022

DOI: https://doi.org/10.22214/ijraset.2022.46145

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VIII Aug 2022- Available at www.ijraset.com

Design and Analysis of Modified Agricultural Sprayer Machine

Ass. Prof. Vaibhav Bankar[1], Namrata Arun Dable[2]
[1]*Project Guide, Department of Mechanical Engineering, Vidarbh Institute of Technology, Nagpur*
[2]*MTech Student, Department of Mechanical Engineering, Vidarbh Institute of Technology, Nagpur*

Abstract: ***India is an agriculture based country in which, 70% of people depends on the outcome of farming. But if we observe that with increase in population the farm gets distributed among the family and because of this, farmer in India held averagely only two acre farm. Also economically, farmers are very poor due to which they are unable to purchase costly equipments hence they use traditional method of farming. In this project we'll take a look at solar operated pesticides sprayers on wheels. A sprayer of this type is a great way to cover large areas such as lawns quickly and easily. Solar spray are the ultimate cost effective solution at the locations where spraying is required. This study attempts to provide a comprehensive solution to agriculture's future energy requirements. Spraying does not happen all year long. As a result, the same PV (Photo-Voltaic) system used in solar sprayers may be used to power other agricultural operations such as pumping and lighting. Increased pricing and no availability of traditional power or fuel at peak times in remote areas are two variables that influence their adoption. As a result, the focus should be on designing and developing self-contained renewable energy sources that can provide consistent electricity and meet the energy needs of farmers***
who are far away from their farms.
Keywords: Agricultural Sprayers, Solar Power, pesticides, Agro-spray, Conventional energy, power sprayers, knapsack Sprayers.

I. INTRODUCTION

Spraying of pesticides is an important task in agriculture For protecting the crops from insects. Farmers mainly use Hand operated or fuel operated spray pump for this task. This conventional sprayer causes user fatigue due to excessive bulky and heavy construction. This motivated us to design and fabricate a model that is basically solar sprayer In our design, here we can eliminate the back mounting of Sprayer ergonomically it is not good for farmer's health point of view during spraying. In this way here we can reduce the users fatigue level. There will be elimination of engine of fuel operated spray pump by which there will be reduction in vibrations and noise. The elimination of fuel will make our spraying system eco-friendly. So with this background, we are trying to design and construct a solar powered spray pump system.

Now days there are non-conventional energy sources are widely used. The energy which is available from the sun is in Nature at free of cost. In India solar Energy is available around 8 months in year .so it can be used in spraying operation. Solar pesticide sprayer can give less tariff or price in effective spraying. Solar energy is absorbed by the solar Panel which contains photovoltaic cells. The conversion of The solar energy into electrical energy is done by these cells.

This converted energy utilizes to store the voltage in the DC Battery and that battery further used for driving the spray Pump. Solar spray are the ultimate cost effective solution at the locations where spraying is required. This solar-powered spray pump system uses solar energy as source. Solar energy is first used to charge a storage battery. The solar energy stored in the battery is utilized to operate motor which functions as pump. As the name of the paper suggests, it deals with the constant discharge of pesticide, compress air control system, solar power, battery charging, monitoring as well as timer and non-conventional power controlling techniques. As far as controlling is concerned, it include the parameters such as pressure, pesticide level, battery voltage, current, solar cell and discharge condition.

In this paper we are trying to make unique equipment for cultivation users. Mostly in the forming process pesticide spray is taking a critical role due to poison properties of chemical. So, in this paper we have committed to do something unique and useful equipment with non-conventional source technique. Also reduce the weight of unique solar spray jet as compare to diesel spray jet.

II. CLASSIFICATION OF SPRAYING SYSTEMS

In India there are different types of sprayer can be used according to the growth of different types of crops as fallow:

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A. Hand Operated Sprayer

Hand operated sprayer is operated by hand so that the discomfort occur while spraying.

B. Engine Operated Sprayer/Fuel Operated Sprayer

As we know that engine operated sprayer is working on petrol. Petrol is costly fuel so in farmer economical point of view it is not good.

C. Electric Motor Pump Sprayer.

Electric motor pump sprayer is used electricity for charging battery. In this way the pump can drive according to battery charging, in the above sprayer there are some drawbacks.

Such as,

1) Hand operated sprayer cannot be use continually spraying. We can say that it cannot be used for long time.
2) Engine operated sprayer can be operated on petrol so it is not possible to use every farmer.
3) Here 70% of people can be live in rural areas. In rural areas there are insufficient electricity. So it is not possible to use electric motor pump for spraying.

III. PROBLEM IDENTIFICATION

In India, 73% of population is directly or indirectly dependent upon the farming. Hence India is now an agricultural based company. But till now farmers face numerous problems.

1) *Pests:* Farmer's productivity is threatened by pests. Pests are a major threat to food production. Climate change produces warmer temperatures and increases CO2 gases, rainfall and drought that enhance disease, pests and weeds. Better knowledge and understanding of pest behavior under different projected scenarios is required to adopt and develop new technologies to respond to threats resulting from climate change.
2) *Lack of Mechanization:* In spite of the large-scale mechanization of agriculture in some parts of the country, most of the agricultural operations in larger parts are carried on by human hand using simple and conventional tools and implements like wooden plough, sickle, etc. This is specially the case with small and marginal farmers. Due to poor mechanization and crude agricultural techniques the farmers don't get a good value for their produce. Strenuous efforts are being made to encourage the farmers to adopt technically advanced agricultural equipment.
3) *Short Supply of Electricity:* Rural areas face serious problems with the reliability of power supply. In a country like India most of the people in rural areas depend on agriculture. They also face a problem of erratic and random electricity supply in villages. Because of this, farmers have to make multiple visits to the farms at odd timings just to turn on the pumps.
4) *Existing Methods:* Ergonomically imperfect: Most of the existing spraying techniques are either very heavy to use or incompletely mechanized which results in problem relating to their health and economic condition. Demanding efforts are being made to reduce the stress and fatigue caused during farming activities in order to carry out farm operations timely and to economize the agricultural production process.

IV. OBJECTIVE

In this project we are trying to make unique equipment for cultivation users. !mostly in the forming process pesticide spray is taking a critical role due to poison properties of chemical. So, in this project we have committed to do something unique and useful equipment with non-conventional source technique. Also reduce the weight of unique solar sprayer as compare to diesel sprayer.

The main objective is to utilize the inherently available solar energy in spraying operations on wheel.

1) To cut down the cost employed for spraying machines.
2) Decreasing the operational cost by further introducing new mechanisms.
3) To decrease labor costs by advancing the spraying methods.
4) To consume zero electricity.
5) Uninterrupted spraying operation at the field throughout the year.

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V. BLOCK DIAGRAM

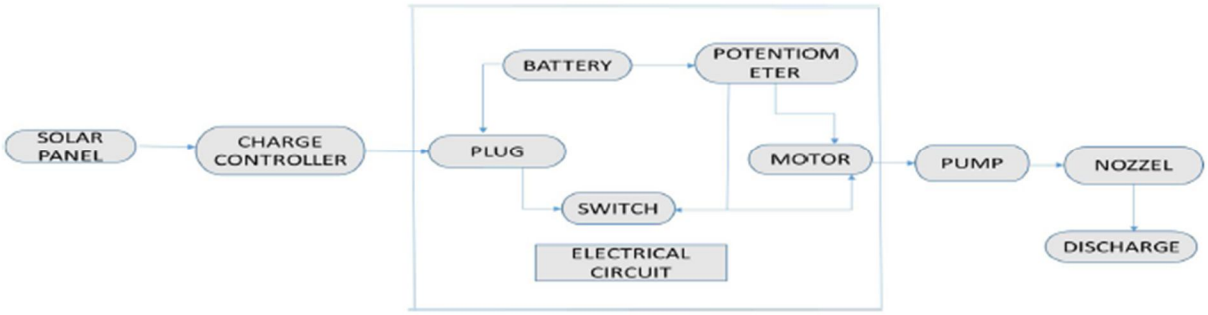


Fig.1. Block Diagram

VI. WORKING PRINCIPLE

It includes a solar panel, a DC pump, a battery charging kit, a pesticide tank, and spray nozzles, among other things. It is powered by solar energy. The solar panel absorbs the solar energy first. This solar energy is converted into electrical energy by the photovoltaic cell. This electricity is then used to charge the battery. After that, the battery will be used to power the DC motor. A DC motor operates a DC pump, which suctions liquid from the intake of the liquid tank. The liquid will then be sprayed from the DC motor outlet through a nozzle linked to the spray pipe**.**

VII. COMPONENTS OF A SOLAR-OPERATED PV SYSTEM FOR SPRAYING

Components Used: Components are chosen to maximize the product's output. The following are the components that are employed as follows.

A. Tank

A water tank is a water storage container. Water tanks are used to store water for a range of applications, including drinking water, irrigated agriculture, fire control, agricultural farming (both plants and animals), chemical manufacturing, food preparation, and a variety of other uses. The overall design, building materials, and linings of a water tank are all specified in specifications. Plastics (polyethylene, polypropylene), fiberglass, concrete, stone, and steel (welded or bolted, carbon, or stainless) are among the materials used to make a water tank. Tank is used here to store pesticide solution. Tank capacity is 20 litre. It is also have manual pump in case there is no power in battery.



B. Nozzle

A nozzle is a device used to control the direction and properties of a fluid flow as it exits (or enters) an enclosed chamber or pipe (especially to improve velocity). A nozzle is a pipe or tube with a variable cross-sectional area that can be used to guide or change the flow of fluid (liquid or gas). The flow rate, speed, direction, mass, shape, and/or pressure of the stream that emerges from nozzles are widely used to control them. The velocity of fluid increases in a nozzle at the price of its pressure energy.



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C. Spray Gun

It is used to give direction to the pressured solution.



D. Solar Panel

Solar energy is likely the cleanest and most dependable kind of renewable energy today, and it can be used to power appliances in a variety of ways. Solar-powered photovoltaic (PV) panels use photons of light from the sun to excite electrons in silicon cells, converting sunlight into electricity. This electricity can then be used to charge a battery with renewable energy. These panels not only pay for themselves over time by cutting power bills, but they also help to minimize air pollution generated by utility companies.



E. Charge controller

The rate at which electric current is added to the battery is limited by the charge controller. As a result, overcharging and overvoltage are avoided. It uses the Pulse Width Modulation (PWM) technique to gradually stop charging the battery when it exceeds a preset high voltage level and gradually re-enable charging when the battery voltage falls below the safe level.



F. Dc Motor Pump

A 12 V DC Pump Is connected to these lead acid batteries to convert the Electrical Energy into Mechanical Energy. The solar panel can also be connected to this D.C. Pump directly, but the difficulty is the force of the spraying will not be as good as running with the aid of Battery. Hence the need for Battery is essential.



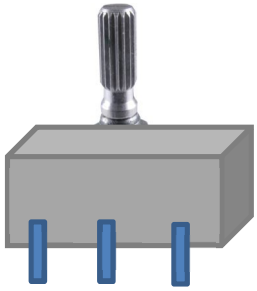
G. Battery

When a battery is supplying electric power, the positive terminal is the cathode, and the negative terminal is the anode. The negative terminal is the source of electrons, which flow and supply energy to an external device when linked to an external circuit. It requires 12V battery to store the energy. Battery is used to drive the DC motor which helps in air blow as well as drive motor pump. Sometimes, it also used for lighting LED lights to work in night or mobile charging for formers used in their field.



H. Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider.



I. Voltmeter

A voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit.



Volt meter

VIII. CALCULATION OF PROJECT

A. Selection of Spray Pump

According to spraying capacity, the spray pump is selected.
Type: Centrifugal Pump. Liquid Discharge = 2.9 lit/min.
Speed= 3600 rpm. Power=3.5 W

B. Selection of Battery

According to pump operating power, battery is selected.
Type: Lead acid battery. Voltage=12 V Current=8 A When the circuit is short then, Voltage =12 V, Current = 2.4 A
Power = Voltage x Current = 12 x 2.4= 28.8 W

C. Selection of Solar Panel

According to battery output power, solar panel is selected.
Power = 20 W Dimensions: 500 mm x 22 mm x 340 mm
Weight =2.0 kg Open Circuit Voltage =21.6 V Short Circuit
Current =1.318 A Operating Current =1.176 A

D. Current Produced by Panel and Charging time of the Battery

(i) The current produced by the solar panel (I) was calculated by knowing the maximum power (P) of the solar panel and the voltage rating (V) of the battery that is given by I = P/V Therefore, I = 20/12 = 1.66 A
(ii). Charging time (T) was computed by taking the ratio rating of battery in ampere hour (Ah) to the total current supplied by the solar panel. T = (battery rating in ampere hour) / (total current consumed by the solar panel)
Therefore, T = 8 / 1.66 = 4.79 hr.

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Volume 10 Issue VIII Aug 2022- Available at www.ijraset.com

IX. DESIGN OF SOLAR PESTICIDE SPRAYER

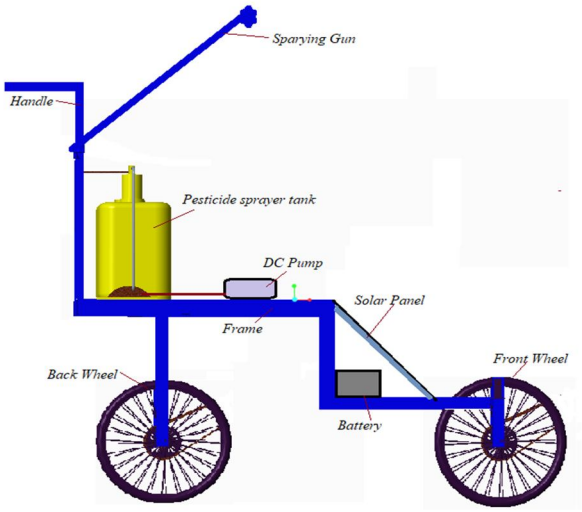


Fig 2. Basic Model of solar pesticide sprayer

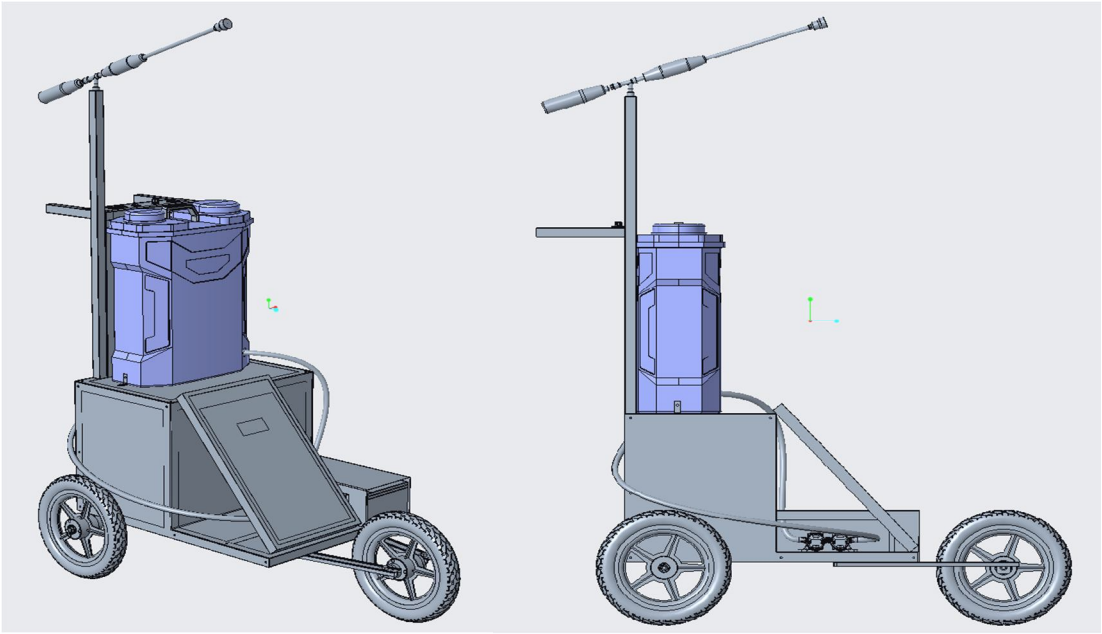


Fig.3. Design Model of solar pesticide sprayer

X. ADVANTAGE

The solar sprayer has many advantages :

1) Besides reducing the cost of spraying,
2) There is a saving on fuel/petrol for spray operations etc .
3) The transportation cost for buying petrol is saved.
4) The solar sprayer maintenance is simple.
5) There is less vibration as compared to the petrol sprayer.
6) The aim of improving spraying quality and reducing physical effort for the operator.
7) The farmer can do the spraying operation by himself without engaging labour, thus increasing spraying efficiency.
8) It is multipurpose machine.

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9) Easy to operate and user friendly.
10) Very less pollution on other models.
11) It is portable
12) Unit cost is very cheap one.
13) Maintenances cost is low.
14) Easy to assemble.

a) Farming is one of the oldest and important business ever done by humans but in most parts of the world it is done in traditional way. Though, farmers are adapting to changing times but there are many more things that's need to be done. SO solar spray mechanism is one of the system through which forming is easily and cost effectively done by formers.
b) At present time we use Power sprayer in two stroke petrol engine which pollutes our environment. It requires regular maintenance and filter cleaning regularly. It costs around Rs.70 / hr. As demand of energy increasing, its cost is increasing too. To deal such things solar powered spray mechanism is essential to used, it very much helpful for formers.
c) The solar power system in the sprayer facilitates lighting of 'wireless light traps' which controls insect pests and reduces the number of insecticide sprays by fifty percent cutting the cost of cultivation.
d) This also reduces pesticide residues in the agriculture, horticulture and animal products, improving the quality of the products. The light traps control effectively the mosquitoes too.

XI. DISADVANTAGES

1) Each formers cannot offered the solar spray system because the cost, if government helps to formers to reach such equipment to formers then it is helpful for them.
2) How to use ? is questions for formers. Formers must be trained about such mechanism before used.
3) Adjust solar panel to spray mechanism accurately otherwise panel may damage.
4) It only works when sunlight is there or in clouded season it can't work properly.

XII. RESULTS AND DISCUSSION

The developed sprayer also compliant the FAO (1994), BIS- 3906 Part I (1982). Matthews and Thornhill suggested that the capacity of the tank should be about 15 litres. Garg (1989) has suggested tank capacities as 10 l for low volume and 12 to 16 l for medium volume sprayers. Considering total discharge: 1.83 l/min, required pressure: 3 kg/cm2, motor efficiency: 0.80 and pump efficiency: 0.70 required power for motor-pump set calculated was 16.7 W.

The net power required for motor-pump set was computed with 25% safety factor as 19.5 W. As 20 W motor pump set commercially available, 20 W motor was selected for the development.

The developed electronic controller was evaluated for its performance and reliability at different cutoff voltage values for 6 h of load conditions. The controller was also integrated with mobile charging module, which enables the system to be used as mobile charging and enhances its application. It was efficient in preventing the battery from deep discharging state (i.e. below 10.5 V). Lead sulfation occurs when power is being taken off from the battery after achieving battery voltage 10.5 V. It forms hard crystals of lead sulfate, which cannot be recovered by standard charging process. The developed charging module was also tested for charging of Lead acid battery through SPV panel. The charging module was effective in delinking the solar power to battery after complete charging to prevent over charging.

The overcharging of lead acid battery reactions begin when the majority of lead sulphate has been converted, typically resulting in the generation of hydrogen and oxygen gases and in turn drastically affecting the battery life. The current for charging is ominously related with irradiation. It was found that even with 65% of irradiation (650 W/m2), the selected battery could be charged fully within 2.5 to 3 hr.

Laser diffraction test of both the selected nozzles were suitable for pesticides spraying (Table 1). The value of DV90 for XR11002VP (Y) and XR11002VP (B) nozzle was 258.10 and 350.9 at 2.8 kg/cm2 (40 psi), respectively. The XR11002VP (Y) nozzle falls under medium droplet size spray application. However, the XR11002VP (B) nozzle may be classified as coarse application. The relative span of both the nozzles was found minimum (1.28 and 1.32) at 2.8 kg/cm2 (40 psi). It indicated that the distribution of droplet size in the spray spectrum was uniform. It signifies that the selected nozzles require to be operated at 2.8 kg/ cm2 (40 psi) for maximum efficiency of nozzles as well as spray quality.

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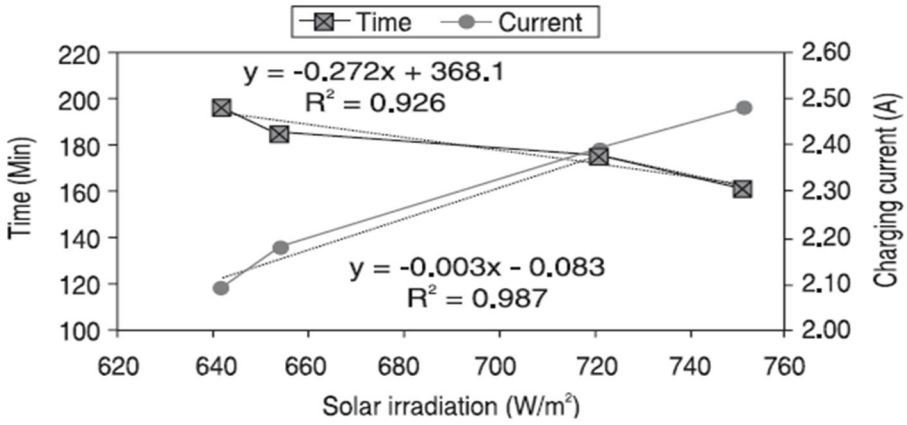


Fig 3. Relationship of solar irradiation, charging current and time for 14 Ah lead acid battery

Table 1: Nozzle characteristics at different hydraulic pressure

Pressure kg/cm² (psi)	Empirical drop size distribution functions			RSF
	D10	D50	D90	
	XR11002VP (Y)			
1.4 (20)	92.46	173.20	316.00	1.29
2.1 (30)	76.87	130.30	264.80	1.44
2.5 (35)	61.20	136.80	295.00	1.71
2.8 (40)	73.02	145.10	258.10	1.28
3.1 (45)	72.10	141.40	251.40	1.27
	XR11002VP (B)			
1.4 (20)	110.60	328.60	740.60	1.92
2.1 (30)	100.90	237.90	502.20	1.69
2.5 (35)	85.66	184.30	304.60	1.44
2.8 (40)	87.30	165.20	350.90	1.32
3.1 (45)	77.39	161.40	321.50	1.51

The developed solar powered sprayer with 14 l capacity is equipped with efficient system for preventing the battery from deep discharging as well as overcharging and performed efficiently at 2.8 kg/cm2 (40 psi) operating pressure for application of pesticides. The spray spectrum
was also found uniform with the selected nozzle and operating pressure. It would be considerably enhance quality of spray and ultimately chemical efficacy as well as efficient pest control. This battery can be fully charged in three hours and the sprayer can be operated for six hours with this battery. The mean heart rate and BPDS were lowest for solar sprayer and covered area more than twice (3000 m2) compared to the manual and air assisted sprayers indicating lower physiological demand and discomfort to body parts.

XIII. CONCLUSION

It is observed that, this model of solar sprayer pump for agriculture is more cost effective and gives the effective results in spraying operation. As it runs on the non conventional energy source i.e. solar energy, it is widely available at free of cost. In now days where world is moving towards the finding the new ways for the energy requirement, it can be a better option for the conventional sprayer. We have given the best option to farmer who economically challenged and facing electrical problem like load shading now days. As India is a developing country, this product can be become more popular in rural areas.

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The proposed system was tested with AC charging as well as solar charging. From the results it was found that the current and time required for charging the full battery capacity of 12V, 14Ah by practically is 14.15 hours. The fully charged battery can be used to spray 580 liters of fertilizer, which approximately spray 5-6 acers of land it was also found that, if we charge the battery in a day it can used to spray 200 liters of fertilizer. The install cost of the proposed system is little more as compare to conventional sprayer but the running cost of the system is very less. The developed system used for spraying the fertilizer, pesticides, fungicides and painting.

A. Future Scope

1) The overall weight of the tank can be minimized by modeling techniques.

2) The battery backup can be increased by adopting some new technology in electronic fields.

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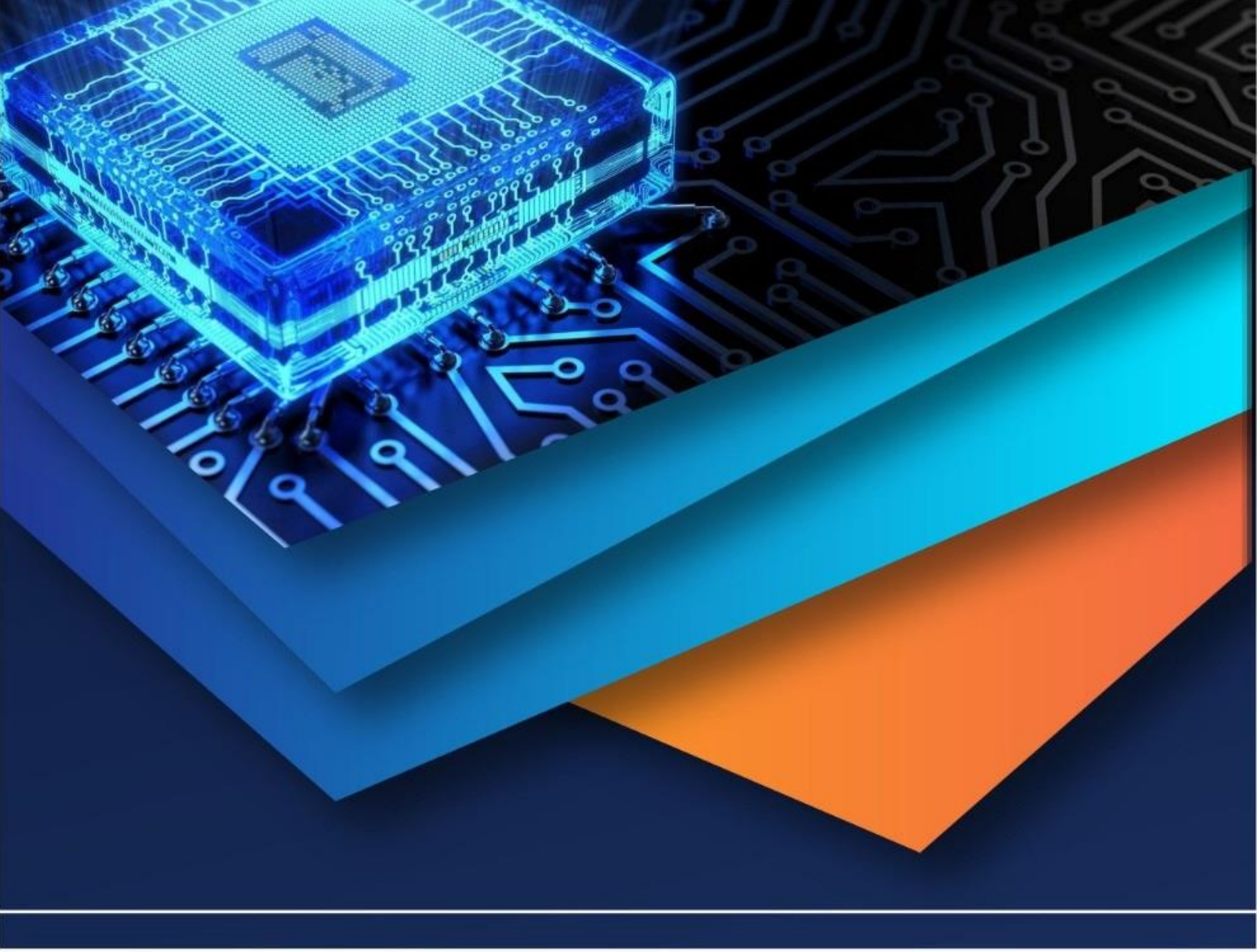
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