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Development and Evaluation of Solar Agro Sprayer

Srustidhara Rout[1], Supravati Ekka[2], Dibyajyoti Singh[3], Dr. Satyananda Swain[4], Prof. Gayatri Mohanty[5]
[1, 2, 3]*UG Students, Department of Agricultural Engineering, Gandhi Institute for Technology (GIFT), Bhubaneswar, India*
[4, 5]*Department of Agricultural Engineering, Gandhi Institute for Technology (GIFT), Bhubaneswar, India*

Abstract: ***In the agribusiness area, the splashing of pesticides is a significant assignment to shield the harvests from bugs for getting high returns. Be that as it may, ranchers have been fundamentally utilizing customary ordinary procedures like hand-worked and fuel worked sprayer frameworks for splashing pesticides. Fuel is costly and in many spots, fuel may not be accessible. Assuming that hand-worked splash frameworks are utilized, the work efficiency diminishes and the effectiveness will be low. The utilization of sun based energy framework is a substitute answer for these restrictions. Subsequently, a sun-based controlled horticultural pesticide sprayer is planned and created. The framework was planned and manufactured by considering boundaries like wanted splashing limit, low weight, minimal expense, easy to use nature, high working time, and quicker inclusion of region. Along these lines, the sunlight-based sprayer was created to be an incentive for cash items in the farming area. For planning the model, the regular sprayer framework was examined to figure out the instrument for the showering process. Numerical models were created in the wake of embracing appropriate suspicions for computation of force of the engine expected for showering a known amount of liquid. The parts expected for the framework were chosen by settling for known input esteems and thinking about their accessibility in the market. The framework was created and plans were made on the framework to make it versatile and to permit the client to convey it on his back while inactivity. The framework was created by the plan boundaries and field tried by the standard test conditions.***

Keywords: Pesticide, Solar sprayer, Application rate, Field capacity, Solar Energy

I. INTRODUCTION

A sprayer is a mechanical gadget used to shower the fluid-like herbicides, pesticides, fungicides, and manures to the harvests to keep away from any irritation and control the undesirable plant species. Sprayer gives ideal use of pesticides or any fluid with least endeavors. In Indian homesteads commonly two kinds of splash siphons are utilized for showering, they are hand-worked shower siphon and fuel worked shower siphon, and hand worked shower siphons are generally famous. To kill the vermin and bugs, pesticides, and manures are splashed either physically or by utilizing sprayers. Prior, the pesticides and composts were sprinkled physically, however they will bring about unsafe impacts on ranchers. To conquer this issue, different showering strategies have been created. A sun-oriented worked sprayer is not difficult to deal with and upkeep free, henceforth is reasonable to the ranchers. Thusly, a sun-oriented worked sprayer is planned and manufactured. This framework can be worked utilizing sun-based energy or electrical energy. The sun-oriented energy is changed over into electrical energy and is put away in a capacity battery. The fundamental benefits of the current framework are the running, cost lessens to least and consume less time. Sun-based energy from the sun is collected on the sun-powered charger. The board is comprised of photovoltaic cells, which switch photon energy over completely to electric energy. These cells are comprised of silicon semiconductors. The charged battery is utilized to work a DC siphon for showering the pesticides. Charging should be possible utilizing sunlight-based hackneyed. The battery can be charged constantly by appending the cliché on the sprayers. Without board on the sprayers, the release should be possible for a base time of 4 to 5 hours. By changing the battery, the release can be gone on for adding hours. During Rainy Season charging should be possible by electrical gadgets. The proposed framework was tried with AC charging as well as sunlight-based charging. From the review, it was made that the opportunity expected for charging the battery of 12V, 8Ah is 5 hours. The completely energized battery Roughly showers 5-6 sections of land. It was additionally viewed that assuming the battery is completely energized in a day splashing 200 liters of fertilizer can be utilized. The underlying expense of the proposed framework is minimal all the more however the running expense of the framework is exceptionally less. The created framework is utilized for showering the compost, pesticides, and fungicides. The created sun-powered worked sprayer is displayed in Fig.4. The sunlight-based charger is connected to the splash siphon so that, it comes precisely on the tank. In light of tests, found that charged sun-powered siphon showers can be utilized during the daytime between 9 AM to 5 PM. Every one of the tests is effectively done simultaneously. A completely energized sunlight-based splash siphon works for 7-8 hrs constantly and simultaneously it will be charged. Consequently, this advanced model is more viable and eco-accommodating than a hand-worked and fuel worked shower siphon.

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The challenge to our Country. Presently a-days the Concept and Technology utilizing this Non-regular energy turn out to be extremely well known for a wide range of improvement exercises. One of the significant regions, which finds the number of applications are in the Agriculture sector. Sun-oriented energy assumes a significant part in drying horticulture items and for water system reason for siphoning the well water in far off towns without power. This innovation on sunlight-based energy can be reached out for splashing pesticides, fungicides and manures, and so on, utilizing sun-oriented sprayers. Keeping the above focuses in view, a sun-based worked sprayer with multipurpose applications has been created.

II. MATERIALS AND METHODS

A. Specifications of Equipment

The hardware subtleties are referenced in this segment and the supplies are pesticide tank, DC engine, DC battery, spout type, and sunlight-based charger.

1) Liquid Storage Tank

Tank limit =16 ltrs.
Material = PVC

2) DC Motor

DC engine is utilized to lift the pesticide from the tank and conveys it to the shower firearm. DC engines have the following determinations.
Model name: KF-2203
Voltage = 12 volts DC
Greatest current = 1.8 A
Greatest Pressure = 0.45 MPa
Fluid release = 2.9 lit/min
Speed = 0-6,000 rpm

3) DC Battery

Model name: Sealed lead corrosive battery 6DFM8.
Weight= 2.5 kg
Limit = 12 volts, 8 Ah
Charging current = 2.4 A (Max)
Backup use: 13.5 V - 13.8 V
Cyclic use: 14.5 V - 14.9 V

4) Nozzle

Nozzle discharge rate is 2.9 lit/min

B. Working Principle

The framework comprises of solar board, charging unit, battery, siphon, and sprayer. The sunlight-based charger conveys a result in the request for 12 volts and 20 Watts capacity to the charging unit. The charging unit is utilized to fortify the sign from the sun-powered charger. The charging unit conveys the sign which charges the battery. As indicated by the charged unit, the siphon works, with the end goal that the sprayer works. Here compost can be put away in a tank. At the point when the sunbeams are falling on the sunlight-based charger power will be created through the sun-oriented cells and put away in the battery. By the electric power in the battery, the siphon works, and along these lines, manures from the tank are showered out through the sprayers. The design of the sun-powered sprayer is displayed in fig.1. There is no support cost and working expense as it is utilizing sun-powered energy and has no contamination issue. Its functioning guideline is extremely simple and it is prudent for the ranchers, which enjoys another benefit that it can likewise create power that power is saved in the battery and it tends to be utilized for both splashing and well as to the light in the houses when there is no ongoing inventory. In sun-based energy mode, sun-oriented energy got by the sun is changed over into electrical energy utilizing a sunlight-powered charger by photovoltaic impact. The result of energy change was utilized to charge a profound cycle battery. The times a battery can be released is known as its life cycle.

For sunlight-based applications, a battery ought to be equipped for being released a few times. In such cases, a profound cycle battery is utilized. In this work, a lead-corrosive collector fills the need. The lead-corrosive battery has properties, for example, high current accessibility, contact voltage, longer life, and greater capacity to charge in contrast with customary batteries. The result of the battery is associated with a DC siphon through an assurance circuit. The DC siphon is chosen due to the benefits, for example, less clamor, longer everyday life, support free, engine speed can be differed a bigger degree by fluctuating the stock voltage and is self-greased up. Siphon is utilized to suck the splashing fluid from the sprayer tank and shower it through the spout. The sprayer comprises of sprayer tank and sprayer pipe. The sprayer tank is comprised of plastic or fiber material to decrease the heaviness of the tank. The limit of the tank is 16 liters and associated with the sprayer pipe with a customizable spout. By changing the spout the result of the stream can be controlled. The entire unit can be conveyed advantageously at the rear of the human body with the assistance of shoulder lashes. The supporting base of the whole unit should have serious areas of strength to be light in weight.

Fig 1 Parts of Solar Sprayer

C. Description of Sprayer

The principal parts of the machines are photovoltaic board 37Watt, 16.4 V DC, STC 250C, and 1000 Watt/m2, the rucksack 12 liters tank,12 volts 7.0 AH dry lead battery, battery worked water siphon, battery case, channel and sprayer handle with spear and spout. The top opening with a cover is for filling and topping off of fluid. An outlet hole at the lower part of the tank is for the release of fluid and lines portions of aluminum metals as fitting adornments.

1) Electrical Power

Electrical power is characterized as how much electric flow streams because of an applied voltage. It is the measure of power expected to begin or work for a heap briefly. Electrical power is estimated in watts (W).

Power = voltage * current … … … … (1.1)

W=V*A

Where,

V=voltage (V)

I=current (A)

P=power (Watt)

2) Efficiency of Solar Cells

Productivity of a sun-oriented cell is characterized as the proportion of the energy result to the energy input from the sun.

PV Efficiency% = yield power (watt)/input power (watt) *100 … (1.2)

The energy yield (watt-hour) shows how much energy is created during the day. The vast majority of the sun's energy arriving at a sun-oriented cell is lost before it very well may be changed over into valuable power. The base measure of energy important to liberate an electron from its band changes with various semiconductor materials. Since sun-based cells can't answer daylight's whole range, the sun-powered cells can't be 100 percent proficient. Another component that limits cell productivity is the coincidental recombination of electrons and openings before they can add to an electric flow. The normal protection from the electron stream in a cell is additionally impacted by temperature. Sun-based cells work best at low not entirely set in stone by their material properties. All cell materials give less proficiency as the working temperature climbs. Consequently, the proficiency of the sun-powered cell is impacted by a few misfortunes (Table 3.1). A portion of these misfortunes are avoidable and others can't be kept away from under ordinary states of creation and use.

3) Pumping Efficiency

Pumping Efficiency is characterized by the need that might have arisen to convey water to the power provided by the exhibit.
Pumping Efficiency %=power expected to convey water (watt)/power provided by the exhibit (watt)*100 (1.3) also, accordingly,
Framework effectiveness %= [PV efficiency (%)/100*Pump productivity (%)/100*100)]….. (1.4)
Stream rate not entirely set in stone by Q=A*V … ..(1.5)
= a*v.… (1.6)

Where,
Q=Flow rate release (m3/sec) or(lit/sec)
A=Area of cross part of pipe (m2)
V=Velocity of stream in pipe (m/sec)
a=Area of the spout outlet (m2)
v=Velocity of the stream at the spout outlet (m/sec)
Static head not entirely settled by
S_{stat} = hs+ hd .… .(1.7)

Where,
H_{stat}=Static head (m)
Hs=Static attractions head (m)
Hd=Static conveyance head(m)
Speed (still up in the air by
Vh=v2s/2g+v2d/2g … ...(1.8)

Where,
V2s/2g=Velocity in attractions head (m)
V2d/2g=velocity in conveyance head (m)
g= Acceleration because of gravity , normally esteems 9.81 m/s2
Grinding (not set in stone by ,
Hf=4Flv2/D*2g … … (1.9)

Where,
Hf = Head lost in the line (m)
F=Co-proficient of the part for the line
L= Length of the line (m)
V=Velocity of the stream in the pipe(m/sec)
g= speed increase because of gravity usually, values 9.81 m/sec2
D=Diameter of the line (m)
All out siphon head not set in stone by
H=H detail +hf+V2/2g … … (1.10)

Where,
H=Total siphon head (m)
Siphon pressure is still up in the air by
P=F/A … … (1.11)

Where,
P=Pressure (N/m2)
F=Force (N)
A=cross segment region of the line,(m2)
A=π/4*d2 … … (1.12)

Where,
D=Diameter of the line (m)
In any case, P=W*H
Where,
W=Specific weight of the fluid (N/m3)
H=Pump absolute head (m

4) Determination of Flow Rate (Laboratory Test)

A cone like jar was utilized for gathering the volume of fluid released into it in ml each moment. An estimating chamber was involved along with the funnel-shaped flagon for precise estimation of the released fluid. An advanced time (stopwatch) was utilized for the recording of time. The method was rehashed multiple times and the differing fluid heads were noted. The mean stream rate was determined and introduced in a plain structure.

5) Determination of Application Rate (Field Test)

A 12 liter limit tank was topped off with fluid. The tank was mounted at the back. The electrical framework was exchanged "on" and the fluid was splashed utilizing the forcing of the siphon. The viable exhibition of the created by commonsense preliminaries in the field. The field test was made in an open field estimating 4m by 25m. The administrator strolled inside space of 0.7 m/s through the test field. The released volume in liters each moment was recorded. The system was recreated multiple times and the mean was not entirely settled.

Fig 2 Laboratory Test

Fig 3 Field Test

6) Calibration of Sprayer

Sprayer was adjusted as underneath:
Area of test plot = Length * Breadth … … … … … (1.13)
Region rodent of sprayer = Area of test plot (ha)*Time taken (hr) … (1.14)
Volume rate = volume gathered (L)/Time (hr)… … … .. (1.15)
Application rate (L/ha) = Volume rate (L/hr)/Area pace of sprayer (ha/hr)… … … … (1.16)

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III. RESULT AND DISCUSSION

It is seen that as the rating of the sun-powered charger increments, weight increments yet the ideal opportunity for charging the battery diminishes when the sunlight-based charger is working at its greatest rating. Hence, by considering the weight and charging time as the measures, a 20W rating sun-powered charger was chosen for the created planetary group.

A. Selection of Spray Pump

As indicated by the splashing limit, the shower siphon is chosen.
Type: Centrifugal Pump.
Fluid Discharge = 2.9 lit/min.
Speed= 3600 rpm.
Power=3.5 W

B. Selection of Battery

As per siphon working power, a battery is chosen.
Type: Lead corrosive battery.
Voltage=12 V
Current=8 A
At the point when the circuit is short then, that point,
Voltage (V) =12 V
Current (I) = 2.4 A
Power = Voltage (V) x Current (I) = 12 x 2.4= 28.8 W

C. Selection of Solar Panel

As indicated by battery yield power, the sunlight-based charger is chosen.
Power = 20 W
Aspects: 0.500 m x 0.022 m x 0.34 m
Weight =2.0 kg
Open Circuit Voltage = 21.6 V
Hamper = 1.318 A
Working Current = 1.176 A

D. Current created by panel and charging time of the battery

(i) The ongoing delivered by the sunlight-based charger (I) was determined by knowing the greatest power (P) of the sunlight powered charger and the voltage rating (V) of the battery that is given by
I = P/V
Thus, I = (20/12) = 1.66 A
(ii) Charging time (T) was registered by taking the proportion rating of the battery in Ampere hour (Ah) to the complete current given by the sunlight-based charge.
T = (battery rating in Ampere hour) / (complete current consumed by the sun-powered charger)
Thusly, T = 8/1.66 = 4.79hr

E. Power Conversion Efficiency of the Solar Panel

The sun based cell power transformation productivity can be determined by utilizing the connection,
Where,
Pin = Incident Solar radiation x Area of the Solar Cell
= I x r x A
Execution boundaries are under Standard test conditions at irradiance of 1000 W/m² = 1000 (W/m2) x 22 x 156 x 10-6(m2) x 36= 123.552W
The result power (Pout) = V x I= 17 x 1.176= 19.992W
Ŋ= (output power/input power)

Ƞ= (19.992/123.552) = 16.18 %
This is the power transformation effectiveness of the sunlight based charger.

Table 1 Technical Parameters of Solar Operated Sprayer

Sl No.	Particulars	Technical Parameters
1	Type of sprayer	Solar operated Knapsack
2	Capacity of the tank	18 L
3	Type of nozzle	1, 4, 8 Hole nozzle
4	Type of pump	Radial piston pump, Centrifugal pump
5	Size of solar panel	20 W
6	Battery	12 V
7	Net weight	18 Kg

Table 2 Field Test Result of Sprayer

S.No.	Types	Discharge Volume (L)	Time Taken (s)	Discharge Rate (L/s)	Area Cover (m^2/s)	Application Rate (L/ha)	Time Taken in hr for 1 ha	Avg time taken (hr)
1	Single Nozzle	0.3	37	0.0081	0.184	440.21	15.09	
		0.4	37	0.0108	0.185	583.7	15.01	15.01
		0.5	37	0.0135	0.186	725.8	14.93	
2	Dual Single Nozzle	0.6	37	0.0162	0.265	611.32	10.48	
		0.7	37	0.0189	0.266	710.52	10.44	10.44
		0.8	37	0.0216	0.269	808.98	10.40	
3	Straight Nozzle with 4 Hole	1.2	37	0.0324	0.319	1015.67	8.70	
		1.3	37	0.0351	0.320	1096.87	8.68	8.67
		1.4	37	0.0378	0.021	1177.57	8.65	
4	Hollow Cone Nozzle with 8 Hole	2.1	37	0.0567	0.409	1386.3	6.79	
		2.2	37	0.0594	0.410	1448.7	6.77	6.77
		2.3	37	0.0621	0.411	1510.94	6.75	

IV. CONCLUSION

In this examination work, the created sun-powered worked sprayer was tried in the exploratory plot and saw that they carry out worked sufficiently. A sunlight-based worked sprayer was produced for showering which involves sun-oriented energy as a wellspring of force. It comprises a sunlight-based charger of 20 W limits, a 12V DC battery, a DC engine, worked by the battery a siphon, to splash the pesticide, and a tank to hold the pesticide. The heaviness of the sprayer was found 18 kg. The speed of the administrator was found 3 km h-1. The hypothetical field limit, compelling field limit, and field productivity of created sunlight-based worked sprayer were found to as 0.7 ha h-1, 0.6ha h-1, and 84.33 percent separately. As the gear utilizes no other outside wellspring of force and that is worked by the client himself, it diminishes drudgery and is very efficient and eco-accommodating as it utilizes sun-based energy which can be effectively reasonable by ranchers. Further, its power can likewise be utilized for multi-reason applications, for example, charging the versatile battery and lighting the homegrown light, etc. The normal time taken for a single spout is 15 hr for 1 ha field.

The typical time taken for double single spout is 10.4 hr for 1 ha field. The typical time taken for a straight spout with 4 openings is 8.6 hr for 1 ha field. The typical time taken for hollow cone nozzle with 8 hole is 6 hr for 1 ha field.

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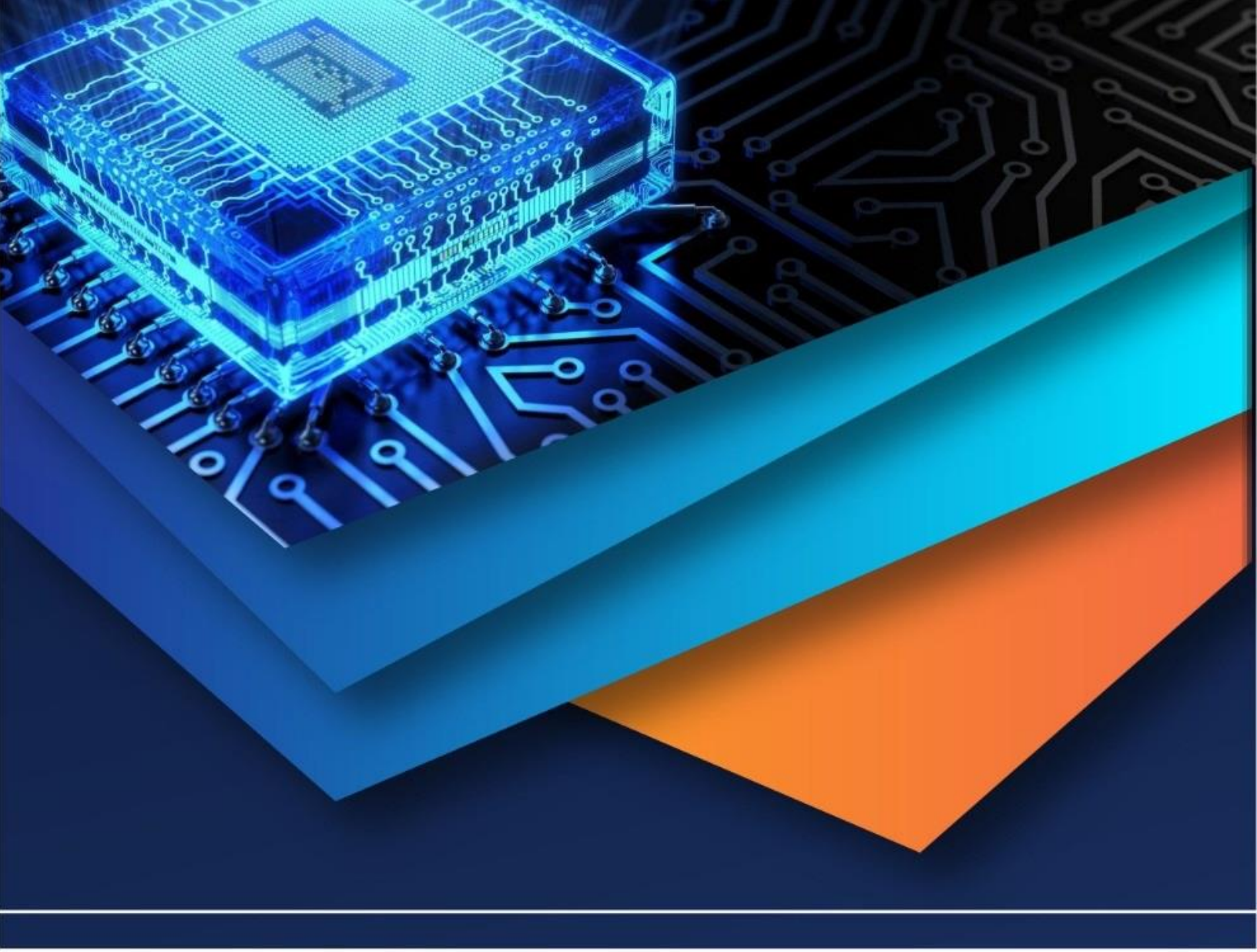

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