A

Capstone Project Execution Report

on

"Electrostatic Spraying System"

Submitted By

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KASEGAON EDUCATION SOCIETY'S

RAJARAMBAPU INSTITUTE OF TECHNOLOGY, RAJARAMNAGAR

DIPLOMA

DEPARTMENT OF ELECRICAL ENGINEERING

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We are grateful to **Mr. A. D. Nikam**, (Head of the Department of Electrical Engineering, Rajarambapu Institute of Technology Rajaramnagar), for giving us an opportunity to carry out the Capstone project work at the institute.

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CERTIFICATE

This is to certify that **Mr. Rohit Sapkal, Ms. Swaliha Mulla, Ms. Akanksha Patil, Ms. Gayatri Patil** from **Rajarambapu Institute of Technology, Rajaramnagar.** having Enrollment No 1817400355, 1817400250, 1817400354, 1817400291 has completed **capstone project planning report** having title **Electrostatic Spraying System** in a group consisting of **4** Candidates under the guidance of the faculty guide.

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Name and Signature of HOD: Mr. A. D. Nikam

Date:

Place: Rajaramnagar

Abstract:

There is an urgent need for new chemical application sprayer in Indian agricultural Pesticides spraying. The present paper aims to design and develop of an air-assisted electrostatic nozzle based on induction-charging with a specific focus on Indian agricultural and geographical Scenario. A new air-assisted electrostatic nozzle has been designed and developed for small scale farms with enhanced performance. This nozzle is light weight, highly efficient, reduces pesticide use and human health risks, and eco-friendly. An air-assisted electrostatic nozzle system is a combination of an air-assisted nozzle and induction based electrostatic charging mechanism. The portable high voltage power supply is generated from a rechargeable dc battery, raised to few kilovolts, in-house with nozzle itself.

Electrostatic principles have been employed successfully in applications for enhanced on– target and reduced off–target deposition of sprays. Industrial applications of paint and other coatings are notable examples. Electrostatics has also been adapted to agricultural application of crop production and protection materials. Successful commercial versions of electrostatic sprayers for greenhouse, ground, and orchard sprayers have been available for several years. Aerial electrostatic application has also been a subject of research and development. But until recently there was no commercial adaptation of electrostatics to aerial applications. Research and development over an extended period culminated in a patent for an aerial electrostatic application system that is currently marketed by Spectrum Electrostatic Sprayers, Inc. Several field performance and efficacy studies were conducted in conjunction with design and development of this aerial electrostatic system. The objective of this work is to document performance of the aerial electrostatic system from various field and laboratory studies with the research prototype that was the basis of the commercial version of the aerial electrostatic spray system

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Figure:

Nomenclature:

1.	DC	-	Direct Current
2.	AH	-	Ampere Hour
3.	Cm	-	Centimetre
4.	Scum	-	Centimetre square
5.	mm	-	Millimetre
6.	USDA	-	United States Department of Agriculture
7.	ULV	-	Ultra Low Volume
8.	L/ha	-	Litter per Hour
9.	UMIST	-	University of Manchester Institute of Science and Technology
10.	SLA	-	Sealed Lead Acid
11.	VOF	-	Volume Of Fluid
12.	SLA	-	Service Level Agreement
13.	OEM	-	Original Equipment Manufacturer
14.	/PLC	-	Programmable Logic Controller

CHAPTER 1

CHAPTER 1: INTRODUCTION

Introduction:

In order to protect food and fibre crops against insect, disease and weed pests, usage of agricultural chemicals such as insecticides , fungicides and herbicide is essential Entomological studies have established that in numerous cases, smaller droplets of pesticide spray provide greater biological efficacy per unit mass of pesticide than do the larger droplets for achieving insect control Thus, the recent concept of spraying is to spray the target pest more efficiently by selecting optimum droplet size and density for maximum retention and coverage. Electrostatic spray technology was invented in the early 1930's and the aim was to improve spray deposition on the canopy. The first electrostatic application system in 1940 However, the droplet size requirement of many target pests are not always clear as there are conflicting requirements in relation to safety, coverage or cost. Customarily, more chemical than theoretically needed is often applied due to the variability in field conditions and the need to ensure complete coverage. Some cases in rather old data, 95% of the chemical applied can be wasted to the ground or at most 50% of mass transfer onto the desired plant. The optimum droplet size for maximum retention with an aqueous solution is reported to be 100 mm or less and such a reduction in droplet size would also improve coverage due to an increase in the number of droplets at the same volume application rate. Thus, if drift is not a problem, a decrease in droplet size increases retention and coverage. The use of small droplets is, however, not so popular with the environmentalists as it is feared that non target plants and organisms outside the treated area may be affected. Electrostatic spraying would offer a possible solution to those environmental problems; by reducing spray drift and improving coverage of chemical to target plant. The idea of electrostatic spraying had been examined as early as in the 1940's, and since then various prototype sprayers and commercial machines have been developed for years. These application areas broadly include ground equipment for spraying plaints of row crops, orchards, and greenhouse, even aircraft spraying.

By using the embedded electrode induction nozzle, which was developed by Universityof Georgia, the commercial greenhouse and row crop electrostatic machines, which are marketed by Electrostatic Spraying Systems, now in routine crop production use.

The electrostatic painting operation is based on one basics principle that opposite electrical charges attract each other. The result is a more uniform coat of paint, less waste and reduced material costs. While the electrostatic painting process was invented for many fields it is still Today’s technology for coating. The latter half of the 20th century was a period of rapid development of electrostatics- based technology for widespread implementation across numerous industrial, commercial, and business sectors. Leading developments include electrostatic processes for anciently applying liquid and powder coatings to manufactured goods, xerographic copying, and precipitation of particulate pollutants from gases, manufacture of abrasive papers, ink-jet printing, etc.

During this same period, significant advances were also made in development of beneficial applications of electrostatics in agricultural and biological systems. Electrostatic spraying has been used in inland fish farms, conveyor belts, meat processing and packing factories, poultry farms and slaughterhouses, processing for the food industry, food and post-harvest products, wood storage and processing, healthcare in details and also agriculture force between them is attractive”. This is the basic principle on electrostatic spraying Pesticide application technique is very important to be success on biological efficacy. There are many subjects that affect the success of the application. These are weather conditions, spray pressure, nozzle type, travel speed, boom height, and etc.. Giles and Blewett (1991) announced that, use of a reduced- volume, charged-spray application system. According to the researches that nozzle was light weight, highly efficient, reduces pesticide use and human health risks, and eco-friendly. The deposition of liquid was enhanced 2-3 fold with electrostatic application under the same conditions while using non-electrostatic nozzle.

In this context, the domain of agriculture will be considered a subset of biology encompassing the photosynthetic production and processing of food, fuels, natural "bars, and forest products include wood pulp and paper. Space prevents a truly comprehensive overview of agricultural and biological applications, and the author's review of selected works as examples of advancements is intended in no way to reject negatively upon works omitted. Additionally, while certain applications in biotechnology at the microscopic level are covered, a multitude of other important electrostatic phenomena and processes at the cellular biological level are beyond the scope of this present review.

CHAPTER 2

CHAPTER 2: LITERATURE SURVEY

Literature Survey:

- **R. C. Anantheswaran and S. E. Law,** "Electrostatic precipitation of pesticide sprays onto planar targets", This paper explain design and development of electrostatic-spraying machines.[1]

The system requirements and characteristics necessary for the design and development of electrostatic-spraying machines uniquely adapted to agricultural pesticide applications are presented. The fundamental approach utilizes an electrostatic-induction nozzle to atomize pneumatically the spray (e.g., 30-50 μm volume median diameter (VMD)) and to charge the conductive liquid (e.g., 10 -1 -10 4 Ωm) typically to a -10-mC/kg. charge-to-mass level. Aerodynamic trajection then disperses the charged pesticide droplets deep into the electrostatically shielded plant canopies where the electric field of the interspersed cloud's space charge (e.g., -20 μC/m3) is mainly relied upon for deposition. While the transient charge- transfer capability of living plants has been experimentally verified as adequate for electrostatic, spraying, gaseous discharges between sharp leaf tips and incoming charged spray clouds have been shown to introduce a deposit-limiting condition which is dependent upon plant morphology. Mass-transfer studies of the agricultural electrostatic spraying system have documented increases in droplet deposition efficiency ranging from two- to seven-fold onto various model and biological targets as compared, with similar, uncharged sprays and with, conventionally applied sprays. Field evaluations of full-scale prototype electrostatic pesticide-spraying machines have verified the insect-control efficacy of electrostatic applications of 1/2-rates of pesticide to be equl to conventional spray application requiring full rates.

- **W. Kirk, W. C. Hoffmann and J. B. Carlton,** "Study Production model of USDA-developed aerial electrostatic spray application system", Tjis paper study on model of USDA with the help of electrostatic spray application system.[2]

The study is conducted by I. W. Kirk, W. C. Hoffmann and J. B. Carlton according to this study Production model of USDA-developed aerial electrostatic spray application system are currently being marketed in the US and abroad.

Spray deposit and insect mortality studies conducted on cotton with USDA prototype are summarized. Spray deposits with the electrostatic system where higher than conventional aerial application systems the increased deposit with the electrostatic system did not always produce improved insect control. Generally the aerial electrostatic system with spray rate of 9.4 L/ha provided similar insect control in these studies as conventional aerial spray systems with spray rates of 46.8 L/ha or Aerial ULV spray system with spray rate of 1 L/ha. Lower spray rates contribute to improved operational efficiencies for aerial applicators.These studies show some situations where field performance of the aerial electrostatic spray system exceeds that of conventional systems, and vice versa. That is neither unusual nor unexpected. Most application technologies have niches in which they are best adapted. However, in general terms, aerial electrostatic application methodology has been shown to have spray deposits and efficacies that are not markedly different from conventional aerial application methodologies. Other factors, such as operational efficiencies associated with the low spray rates of electrostatic systems, could be an important factor favoring aerial electrostatic applications.[1]

- **S. Edward Law, "**Electrostatic Pesticide Spraying", This paper explain of concept and practice of pesticides spraying with help of electrostatic system.[3]

The system requirements and characteristics necessary for the design and development of electrostatic-spraying machines uniquely adapted to agricultural pesticide applications are presented. The fundamental approach utilizes an electrostatic-induction nozzle to atomize pneumatically the spray (e.g., 30-50 μm volume median diameter (VMD)) and to charge the conductive liquid (e.g., 10 -1 -10 4 Ωm) typically to a -10-mC/kg. charge-to-mass level. Aerodynamic trajection then disperses the charged pesticide droplets deep into the electrostatically shielded plant canopies where the electric field of the interspersed cloud's space Charge (eg, -20 μC/m3) is mainly relied upon for deposition.

While the transient charge- transfer capability of living plants has been experimentally verified as adequate for electrostatic, spraying, gaseous discharges between sharp leaf tips and incoming charged spray clouds have been shown to introduce a deposit-limiting condition which is dependent upon plant morphology. Mass- transfer studies of the agricultural electrostatic spraying system have documented increases in droplet deposition efficiency ranging from two- to seven-fold onto various model and biological targets as compar, d with similar, uncharged sprays and with, conventionally applied sprays. Field evaluations of full-scale prototype electrostatic pesticide-spraying machines have verified the insect-control efficacy of electrostatic applications of 1/2-rates of pesticide to be equal to conventional spray application requiring full rates.

- **Appah S, Wang P, Ou M X, Gong C, Jia W D**, "Review of electrostatic system parameters, charged droplets characteristics and substrate impact behavior from pesticides spraying" In this paper study of application of Electrostatic spraying.[4]

Electrostatic spraying application is adopted in crop protection to prevent pest infestation, to improve product quality and to maximize yield. It involves a superposition of charges to pesticide spray droplets to attract substrate ions at obscured surfaces. The droplets wraparound effect reduces off-target deposition, enhances on-target spray and invariably improves spray efficiency. Electrostatic spraying system works effectively at optimum parameters in combination with charging voltages, application pressures, spraying height regimes, flow rate, travel speed, electrode material, and nozzle orientation. Many combinations of the system parameter settings have been systematically used by researchers for the electrostatic application, but there are unknown specific optimum parameters combinations for pesticide spraying. Since droplets chargeability influences the effectiveness of electrostatic spraying system, the parameters that produce ideal charge to mass ratio determine the functionality of the spraying deposition, retention and surface coverage. This article, therefore, analyses electrostatic system parameters that produce suitably charged droplets characteristics for effective impacting behavior of pesticides on substrates. Increasing applied voltages consequently maximizes charge mass ratio to optimum and starts declining upon further increase in voltages beyond a critical.

This review further proposes the selection of an optimum electrostatic parameters combination that yields optimum droplets chargeability in pesticide application. Also, it is necessary to investigate the charge property of substrates prior to pesticide application in order to superpose the right opposite charge on spray droplets at rupture time during electrostatic spraying system. Although the potency of pesticides active ingredients is determined mostly by the product’s mode of action, application mechanism can also aid the functionality of the chemicals. Therefore, improving the efficiency of spray necessitates the need to include the surface-active agents, which is also known as the adjuvants, in pesticide formulation.The adjuvants serve the purpose of lowering the surface tension of the solution to improve the droplets’ spreading and impinging behavior on substrates.while application systems significantly influence spray droplet characteristics, deposition and retention. Recently electrostatic spraying system is an innovative plant protection strategy yearning to over come the shortfalls in pesticide wastage, groundwater pollution and environmental contamination. It is a system in which an electrical charge is superposed on droplets to impact on substrates for deposition, attraction, and retention. The charge injection to droplets greatly enhances abaxial and adaxial spray deposition and retention improves canopy penetration at reduced application rate. Works on both abaxial and adaxial substrates deposition from electrostatic spraying are ongoing.

This paper reviews the parameters of the system, charged droplet characteristics and impact behavior on substrates. Mainly the substrates to deposit charged spray droplets must be able to absorb the ingredients. Some plants and insect pests largely possessions in architecture to attract electrostatic charges injected to spray droplets for substrate adsorption. Such substrate charges must be taken into consideration in electrostatic pesticide spraying so that the required charge can be produced by the electrode for effective application. A high voltage charge is often pinned to spray droplets from electrode attachment to nozzles. The technology enhances agrochemical spraying by improving spray droplet characteristics, droplet deposition, and wraparound effect. The characteristic eature of the charged droplets and their impact behavior on substrates are attributable functions of electrostatic system parameter.

- **G. A. Mathews,** "Modeling of electrostatic-based pesticide spray systems Concepts and Practice", In this paper method of concept of modeling electrostatic spray systems.[5]

A microscopic model for the electrostatic spraying system is presented to investigate the effect of the voltage applied to the induction nozzle on the droplet's charge, mobility, and charge-to-mass ratio. The variation of these parameters along the jet was also included. The model also lays particular emphasis on the effect of the applied voltage on the spray current and the charge density at the nozzle. A macroscopic model for the electrostatic spraying system is also presented. The objective of the model was to study the spatial distribution of the droplet charge density, transit time, and trajectory in the region between the nozzle and the target in terms of the flow velocity of the spray and the space-charge-produced electric field. On the macroscopic scale, both the droplet charge density and the spray current increase with the voltage applied to the charging electrode. With the decrease of the spray flow velocity, the space-charge-produced electric field becomes dominant and tends to: contract the droplet trajectories toward the axis of the spray system, and hence enhance the droplet deposition efficiency; and decrease the charge density at the target with the possibility of minimizing back-ionization. On the microscopic scale, induction charging eliminates the ion current from the current to the target and the associated back-ionization.

- **W. Kirk, W.C. Hoffmann, J. B. Carlton**, "AERIAL ELECTROSTATIC SPRAY SYSTEM PERFORMANCE", This paper introduce a performance of electrostatic spray system.[6]

Aerial sprays, Aircraft, Nozzles, Electrostatic, Spray, Droplets, Agricultural chemicals. Production models of a USDAdeveloped aerial electrostatic spray application system are currently being marketed in the US and abroad. Spray deposit and insect mortality studies conducted on cotton with the USDA prototype are summarized. Spray deposits with the electrostatic system were higher than with conventional aerial application systems. The increased deposits with the electrostatic system did not always produce improved insect control. Generally, the aerial electrostatic system with a spray rate of 9.4 L/ha provided similar insect control in these studies as conventional aerial spray systems with spray rates of 46.8 L/ha or aerial ULV spray systems with spray rates of 1 L/ha. Lower spray rates contribute to improved operational efficiencies for aerial applicators.

- **M.R. Jahannama, A.P. Watkins and A.J. Yule,** "Examination of Electrostatically charged sprays for Agricultural spraying Applications", This paper imtroduce a applications of Electrostatically Agricultural spraying system. [7]

Study conducted by M.R. Jahannama, A.P. Watkins and A.J. Yule Thermo fluids division, department of mechanical Eng., UMIST, PO BOX 88, Manchester M60 1QD, UK a two fluid, concentric, internal mixing induction-charging nozzle suitable for electrostatic crop spraying of conducting pesticides has been investigated by experimental and computational analyses. Droplet size measurements for both charged and uncharged sprays with horizontal and vertical nozzle situations were carried out. The droplet size distributions of horizontal sprays showed a significant difference between the charged and uncharged cases, whereas there was no remarkable difference between the vertical cases. Tests were made to assess asymmetry of the horizontal sprays comparing droplet sizes across the spray. Specific charge of the spray cloud was measured using a Faraday cage to collect the charged spray. Computational analysis used a VOF model to simulate the flow field inside the nozzle.

This simulation confirmed the creation of a vortex and negative pressure field in the central part of the nozzle. Mixing of the two phases and atomization of the liquid phase by the airstreams are described based on the vortex and suction zone due to the negative pressure field. Experimental and computational results have laid a foundation for further understanding the charging and atomizing mechanisms involved in the twin fluid sprayer. The experimental results presented here in comparison with results reported in literature [6,7,8], show a good agreement in spite of the unspecified situation of the nozzles in the articles. The computational results confirmed the creation of a vortex and negative pressure field in the middle part of the nozzle. This vortex plays a significant role during the mixing of the fluids and the liquid atomization processes. The results, compared with a description of annular gas atomizers given in [9], show the same.[2]

- **Mamidi, V.R., Ghanshyam, C., Patel, M.K., Kapur**, "Electrostatic hand pressure Knapsack spray system with enhanced performance for small scale form", In this paper performance of Electrostatic hand pressure Knapsack spray system.[8]

There is an urgent need for new chemical application sprayer in Indian agricultural pesticides spraying. The present paper aims to design and develop of an air-assisted electrostatic nozzle based on induction-charging with a specific focus on Indian agricultural and geographical scenario. A new air-assisted electrostatic nozzle has been designed and developed for small scale farms with enhanced performance. This nozzle is light weight, highly efficient, reduces pesticide use and human health risks, and eco-friendly. An air-assisted electrostatic nozzle system is a combination of an air-assisted nozzle and induction based electrostatic charging mechanism. The portable high voltage power supply is generated from a rechargeable dc battery, raised to few kilovolts, in-house with nozzle itself. Electrostatic force field application to agricultural spraying, one of the most promising methods to apply the protective liquid based sprays onto the biological surfaces of living crops and orchards, has revolutionized the agricultural pesticide spraying techniques by making advances and developments via off-target pest control to increase the deposition efficiency and surface bioefficacy.

Electrostatic spraying process has been used in many other applications such as thin film deposition, painting, printing etc. [6]-[9]. Electrostatic spraying achieves more complete coverage of difficult targets than uncharged spraying in addition to minimizing wastage and environmental impact from over-dose and offtarget spray drift [10]-[12]. Earlier electrostatic spray systems developed and commercialized in countries such as USA, China etc. were motorized and mounted on tractors, helicopters, and other. The design and development of air-assisted electrostatic nozzle primarily includes design of the air-assisted nozzle, high voltage generation and appropriate method of droplet charging, optimization of different parameters, deposition study onto actual targets etc. The high voltage electrostatic power supply has been provided to charging electrode with a high voltage module (ULTAVOLT +20 kV, 1.5 mA, 30W, for laboratory experiments only). The laboratory experiments were conducted in open air and at ambient conditions (T= 288±2 K, RH= 50±3%). Earlier electrostatic spray systems developed and commercialized in countries such as USA, China etc. were motorized and mounted on

tractors, helicopters, and other vehicles, which is not suitable and economical to Indian farming community because of geographical conditions and economic constraints.

- **Prof. N. M. Jamadar, M. U. Hiware, P. S. Hake, V. H. Bhoi, N. R. Devkulr.,2019** "AGRICULTURAL ELECTROSTATIC PESTICIDE SPRAY PUMP".[9]

In order to protect food and fiber crops against insects, disease and weed pests used agricultural chemicals such as insecticides, fungicides herbicides. With classical methods more chemical than theoretically needed is often applied due to the variability in field conditions and the need to ensure complete. In this case, 95% of the chemical applied can be wasted to the ground, for soil pollution, or at most 50% of mass transfer onto the desired plant. The project shows that electrostatic spraying can offers a possible solution to those environmental problems by reducing spray drift and improving coverage of chemical to target plant. A relatively new product that has made its way to the forefront

in recent years are electrostatic spray technology .Along with reducing spray drift, this type of application equipment can improve canopy penetration ,increase the under leaf coverage, and decrease the total volume per acre applied.

In this project are presented principle of Electrostatic Spraying, the equipments, technological aspects and application. This system is available in large scale but we can implement in small scale also. Electrostatic spray achieves a difficult target than uncharged spray with minimizing wastage and environmental impact from over dose and spray drift.

CHAPTER - 3

CHAPTER 3:PROPOSED METHODOLOGY

Proposed Methodology:

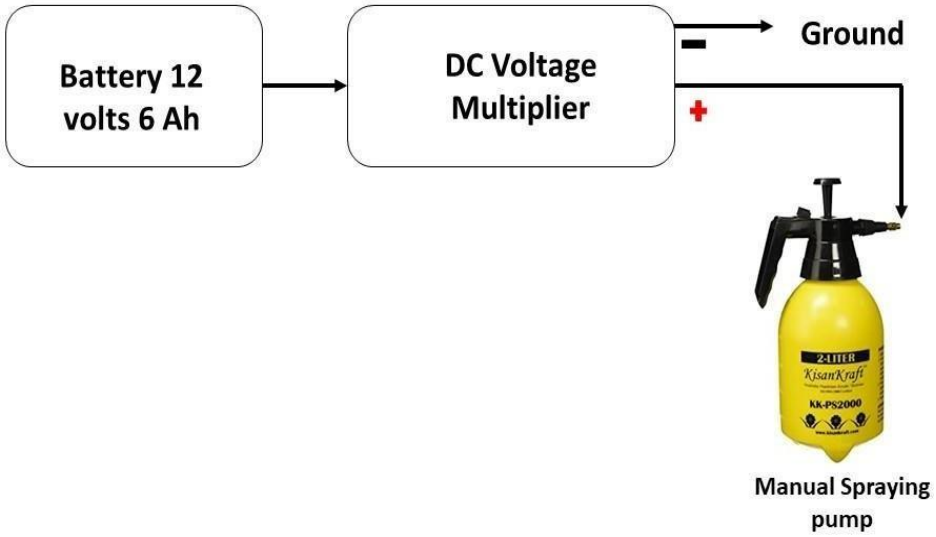

Fig.[1] Block Diagram of Electrostatic Spraying System

- Above fig. shows block diagram of Electrostatic spraying system.
- First battery use as a supply source to provide 12 Volt 6Ah is connected to voltage multiplayer.
- The main function of voltage multiplayer is to multiply 12 volt DC upto 30 KV.
- The voltage multiplier also knows as cascade added rectifier. Is an electrical circuit that converts DC electrical power from a lower voltage to a higher DC voltage, Typically using network of capacitor and diodes. If we applied V volt supply to cascade added rectifier, the 1st pair of capacitor and diode gives 2V voltage. 2nd pair gives 4V voltage and so on.
- This high voltage DC supply obtained from cascade added rectifier is applied to circular electrode, which is held by spray nozzle. The positive terminal of high voltage DC is given to circular electrode and negative terminal is grounded. Because of this the electrostatic field is generated around the electrode. The spray from nozzle is passed through electrode to

getting the positive charge on spray particles of liquid. The tree has already negative charge on it because of grounding effect. Due to principle of electrostatic the spray of liquid efficiently cover the object.

- Then positive terminal of this high voltage DC is directly given to the nozzle of sprayer and negative terminal is given to ground.
- Due to positive terminal the spray particles which pass through nozzle and they get positively charged.
- Then the electrostatic field is formed between spray nozzle and object spray & it cover the front side as well as back side.

The recent concept of spraying is to spray the target pest more efficiently by selecting optimum droplet size and density for maximum retention and coverage. We know that. In a normal spray 60% fertilizers are applied to the plant and 40% just falsies in the direction of wind. That means 40% are wasted.In the winter season there are a lot of water vapors are present in the atmosphere that causes a lot of diseases are come to the plant. That’s time farmers applies a lot of pesticides to the plant for protection.

Big farmers spray pesticides through Tractor and medical class formers applies through STP, small pump or tractor as a rent. That causes a lot of money are flow but profit is not comes a large because of tractors rent.

CHAPTER - 4

CHAPTER 4: DESIGN

Design:

❖ Block Diagram:

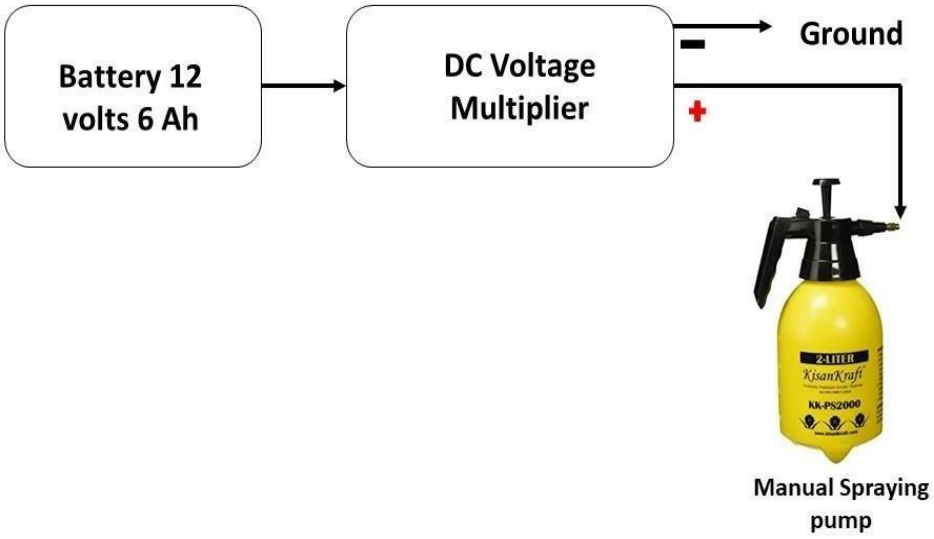

Fig.[2] Block diagram of Electroststic Spraying Syatem.

As shown in figure, Block diagram of Electrostatic spraying system battery use as a supply source to provide 12 volt 7.5 Ah to voltage multiplier. Main function of voltage multiplier is to multiply 12 volt DC to high voltage DC up to 30 KV. Positive terminal of this high voltage DC is directly given to the nozzle of sprayer and negative terminal is grounded, due to positive terminal the spray particle which pass through nozzle and get positively charged. Then the electrostatic field is form between spray nozzle and object spray covers the both side of object front side as well as back side.

❖ Circuit Digram:

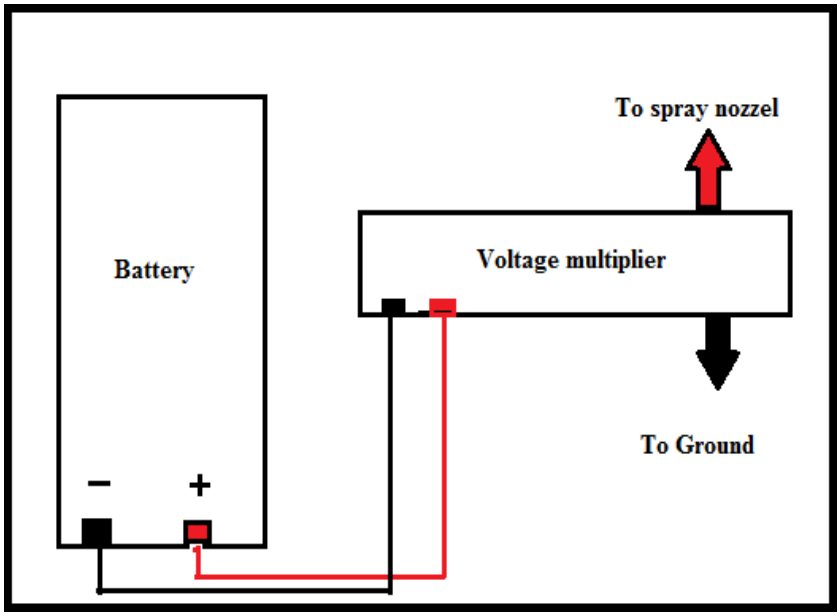

Fig.[3] Circuit diagram of Electrostatic Spraying system

As per the circuit diagram we built the circuit connection. After that battery use as a supply source to provide 12 volt 7.5 Ah to voltage multiplier. The voltage multiplier also knows as cascade added rectifier. Is an electrical circuit that converts DC electrical power from a lower voltage to a higher DC voltage, Typically using network of capacitor and diodes. If we applied V volt supply to cascade added rectifier, the 1 st pair of capacitor and diode gives 2V voltage. 2 nd pair gives 4V voltage and so on. This high voltage DC supply obtained from cascade added rectifier is applied to circular electrode, which is held by spray nozzle. The positive terminal of high voltage DC is given to circular electrode and negative terminal is grounded. Because of this the electrostatic field is generated around the electrode. The spray from nozzle is passed through electrode to getting the positive charge on spray particles of liquid. The tree has already negative charge on it because of grounding effect. Due to principle of electrostatic the spray of liquid efficiently cover the object.

❖ Components Used:

- **Battery:-**

Fig.[4]: 5.3 Battery

➢ **Specifications:**

- Battery has a huge inventory of the oldest and most reliable type of rechargeable battery, the 12V 7.6AH Sealed Lead Acid Battery with T2 Terminals, also known as an SLA battery. Chrome Battery 12v 7.6ah SLA batteries are 'the workhorse of ALL batteries' and are constructed with lead calcium alloy and absorbed glass mat technology, which allows for completely 'maintenance-free' operation.
  - No Spills
  - No leaks
  - No water to check
  - Longest life-cycle product on the market

This maintenance-free design allows for the most powerful, highest amp hour capacity. Fiberglass mat separators and high cell compression extend battery life by delivering superior vibration resistance from the most extreme conditions. All 12v 7.6ah Battery SLA batteries are manufactured with the highest quality materials

and rigorously tested to ensure safety, OEM compatibility, effectiveness and optimal performance.

- **Circuit of Cascade added Rectifier:-**

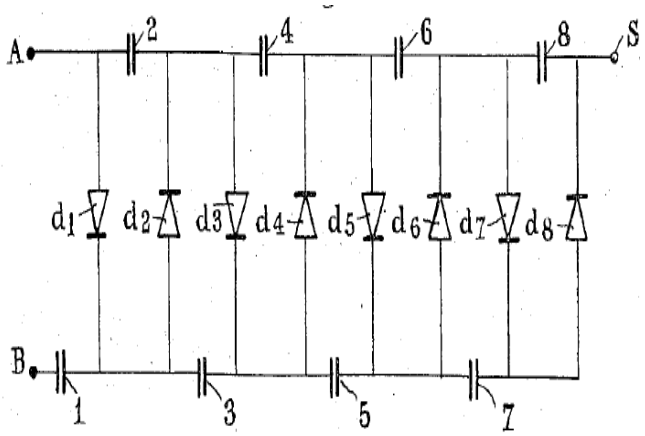

Fig.[5] Circuit ofCascade added Rectifier

- **Specifications:**
  - The cascade added rectifier also known as voltage multiplier. Is an electrical circuit that converts DC electrical power from a lower voltage to a higher DC voltage, Typically using network of capacitor and diodes.
  - If we applied V volt supply to cascade added rectifier, the 1st pair of capacitor and diode gives 2V voltage. 2nd pair gives 4V voltage and so on.

- **Fabrication design of Panel:-**

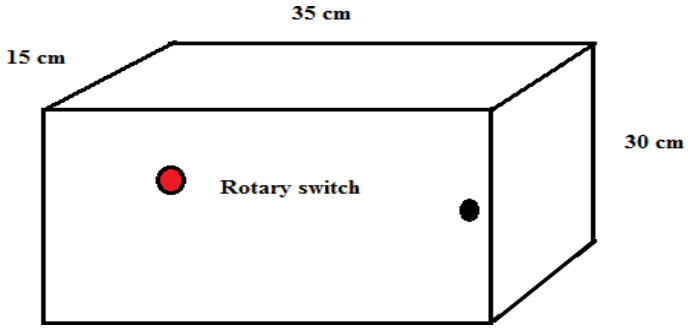

Fig.[6] Layout of panel

- **Specifications:**
  - Height = 30 cm
  - Length = 35 cm
  - Width = 15 cm
  - For fabrication of panel, 2 mm thick metal sheet used and the panel is painted by insulted powder coating for protection purpose.

- **Voltage multiplier:-**

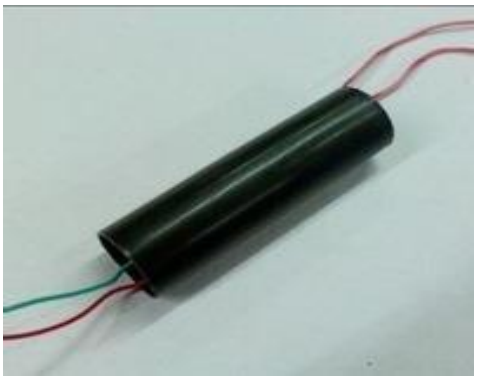

Fig.[7] Voltage multiplier

- **Specifications:**
  - The voltage multiplier also knows as cascade added rectifier. Is an electrical circuit that converts DC electrical power from a lower voltage to a higher DC voltage, Typically using network of capacitor and diodes.
  - If we applied V volt supply to cascade added rectifier, the 1st pair of capacitor and diode gives 2V voltage. 2nd pair gives 4V voltage and so on. This high voltage DC supply obtained from cascade added rectifier is applied to circular electrode, which is held by spray nozzle.
  - Input voltage and Current:-12 V 7.5 AH (DC)
  - Output voltage: - 30KV 15 micro amp (DC)

- **Rotary switch:-**

Fig.[8] Rotary switch

- **Specifications:**

  - A rotary switch is a switch operated by rotation. These are often chosen when more than 2 positions are needed, such as a three-speed fan or a CB radio with multiple frequencies of reception or "channels"Three-deck rotary switch allows controlling three different circuit functions Bottom view of a 12-position rotary switch showing wiper and contacts.
  - A rotary switch consists of a spindle or "rotor" that has a contact arm or "spoke" which projects from its surface like a cam. It has an array of terminals, arranged in a circle around the rotor, each of which serves as a contact for the "spoke" through which any one of a number of different electrical circuits can be connected to the rotor.
  - The switch is layered to allow the use of multiple poles, each layer is equivalent to one pole. Usually such a switch has a detent mechanism so it "clicks" from one active position to another rather than stalls in an intermediate position. Thus a rotary switch provides greater pole and throw capabilities than simpler switches do.

- **Sprayer:-**

Fig.[9] Sprayer

- **Specifications:**

  - Check if the screw cap (1) is firmly closed.
  - Fill the high pressure sprayer as far the two liters line and the close the screw cap (quantity of liquid no more than two liters otherwise the sprayer develops insufficient pressure).
  - Pump (2) until resistance is fail(approximately 30 strokes). Spraying by pressing lever (3).
  - Engage trigger lock for continues spraying(4).

CHAPTER - 5

CHAPTER 5- CONSTRUCTION AND WORKING

Construction and Working :

❖ **Construction:**

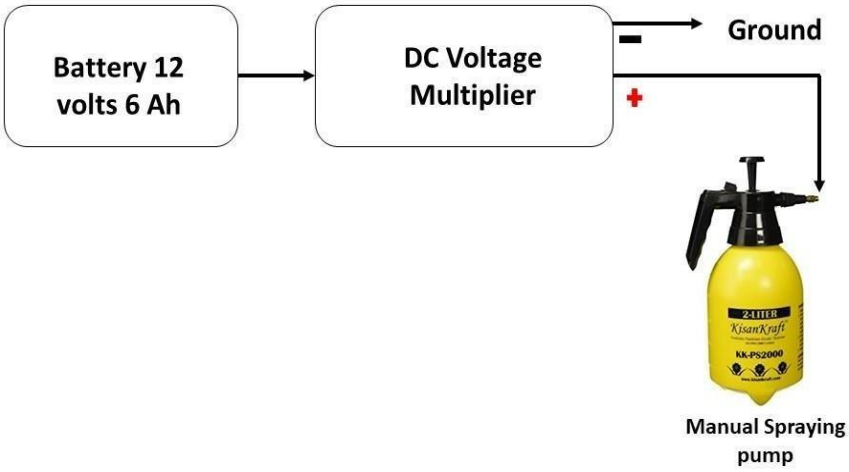

Fig.[10] Block Diagram of Electrostatic Spraying System

- **Battery -**

  Battery has a huge inventory of the oldest and most reliable type of rechargeable battery, the 12V 7.6AH Sealed Lead Acid Battery with T2 Terminals, also known as an SLA battery. Battery has a huge inventory of the oldest and most reliable type of rechargeable battery, the 12V 7.6AH Sealed Lead Acid Battery with T2 Terminals, also known as an SLA battery. Chrome Battery 12v 7.6ah SLA batteries are 'the workhorse of ALL batteries' and are constructed with lead calcium alloy and absorbed glass mat technology, which allows for completely 'maintenance-free' operation.

- No Spills
- No Leaks
- No water to check
- Longest life-cycle product on the market

This maintenance-free design allows for the most powerful, highest amp hour capacity. Fiberglass mat separators and high cell compression extend battery life by delivering superior vibration resistance from the most extreme conditions. All 12v 7.6ah Battery SLA batteries are manufactured with the highest quality materials and rigorously tested to ensure safety, OEM compatibility, effectiveness and optimal performance.

- **Voltage Multiplier -**

The voltage multiplier also knows as cascade added rectifier. Is an electrical circuit that converts DC electrical power from a lower voltage to a higher DC voltage, Typically using network of capacitor and diodes. If we applied V volt supply to cascade added rectifier, the 1st pair of capacitor and diode gives 2V voltage. 2nd pair gives 4V voltage and so on. This high voltage DC supply obtained from cascade added rectifier is applied to circular electrode, which is held by spray nozzle.

- **Spraying system:-**

This extra lightweight handheld sprayer has a pump action facility for continual spraying. Ideally suited for spraying a variety of liquids e.g. water, herbicides, pesticides, insecticides, fungicides and solvent-free treatments.

❖ Working:

- Above fig. shows block diagram of Electrostatic spraying system.
- First battery use as a supply source to provide 12 Volt 6Ah is connected to voltage multiplayer. , the 12V 6AH Sealed Lead Acid Battery with T2 Terminals, also known as an SLA battery.
- The main function of voltage multiplayer is to multiply 12 volt DC upto 30 KV.
- Then positive terminal of this high voltage DC is directly given to the nozzle of sprayer and negative terminal is given to grounded Because of this the electrostatic field is generated around the electrode.
- The spray from nozzle is passed through electrode to getting the positive charge on spray particles of liquid.
- Due to positive terminal the spray particles which pass through nozzle and they get positively charged.
- Then the electrostatic field is formed between spray nozzle and object spray & it cover the front side as well as back side.
- The tree has already negative charge on it because of grounding effect. Due to principle of electrostatic the spray of liquid efficiently cover the object.

❖ Incentives:

- Electrostatic spray method can cover hard to reach surfaces. Effective against highly contagious viruses such as COVID-19, influenza, MRSA. Kills 99.999% of pathogens for up to 30 days. 10 times as efficient as conventional cleaning methods.
- Applies chemicals in a more controlled and efficient manner while removing germs and reducing virus spread.
- Prevents costly financial costs with contagious healthcare infections.
- Reduces how long it takes to disinfect all surfaces by 50% to conventional disinfecting methods.
- With electrostatic spraying, you reduce the time it takes to actually spread and cover as well as disinfect all surfaces, nooks and crannies. Chemicals are applied in a much

more controlled, efficient and orderly manner. It improves infection control and the spread of viruses.

- Effective against highly contagious viruses such as COVID-19, influenza, MRSA. Kills 99.999% of pathogens for up to 30 days.10 times as efficient as conventional cleaning methods.

❖ Some important terms as per followed:

- **Why we are using Electrostatic Spraying System:-**

  In our project,We use Electrostatic spraying system.

  In that case, there are two forces first one is electrostatic force and gravitational force.In comparing the electrostatic force there are similar another one is gravitational force and it is also similar to the electrostatic force. Electrostatic force is better or greater than gravitational force.The electrostatic system ability to achieve targets is also better than gravitational force.

  Because of all these advantages, We have used electrostatic system so it is better or greater than gravitational force.

- **Principle of Electrostatic Spraying System -**

  One of the most important applications of electrostatics is the electrostatic spray coating that is now widely used in automobile industry. The principle of spray coating and the electrostatic crop spraying is the same where a charged cloud of droplets is sprayed towards a grounded object driven by electrostatic force. Although there are many different methods of electrostatic spraying In this simplest case, the nozzle is raised in high potential. Thus the electric field lines departing from the nozzle terminate at the grounded object. . Although there are other electrostatic forces, the largest force in droplet dynamics would be,

  Columbic force

  $$F=qE$$

  where q: electric charge, E: electric field .

  When the charged droplets are emitted at the nozzle, those charged particles are forced to move along the fieldlines according to above force. Since the electrostatic force is much stronger than gravitational or inertia forcesfor a small particle, the motion of a charged particle is easily controlled by the electrostatic force.

❖ **Why we use DC supply instead of AC supply:-**

Because, AC have 50Hz frequency.That means supply is disconnected in 50 times in one second. But for that electrotatis system we need continue supply. So,We are using DC supply using this system instead of AC.

❖ **Why we used 12Volt 6Ah battery:-**

- It I easily availale in the market.
- It have low cost.
- If a battery of a more than 50 volt is used,then it will have more cable thickness,so we are 12Volt 6Ah battery is used.

❖ **Why we prefer dc voltage multiplier:-**

Due to AC voltage waveform crosses zero at every mili second hence the electrostatic filed is not constant, but this problem of AC voltage can be overcome by using DC voltage multiplier we get the constant electrostatic field.

CHAPTER - 6

CHAPTER 6 – RESULT AND APPLICATION

Result and Application:

❖ **Result :**

Area covers by spray in both conditions (with and without electrostatic system)

Bottle:-

- **CASE 1 (When electrostatic spray is not applied):-**

Fig.[11]When electrostatic spray is not applied on bottle

- **CASE 2 (When electrostatic spray is applied):-**

Fig. [12] When electrostatic spray is applied on bottle

C**alculation:-**

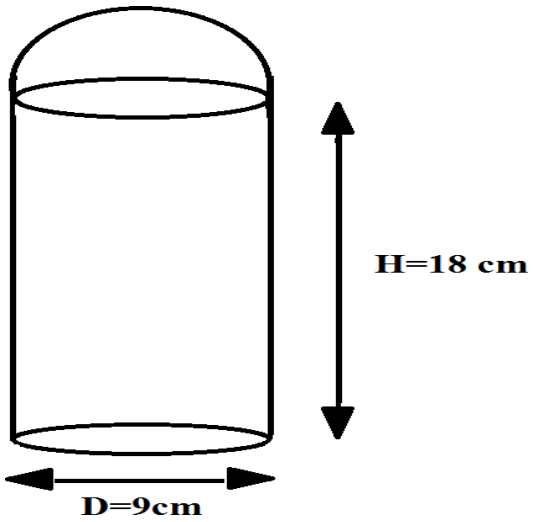

Fig.[13] Surface area of bottle

Case 1 (When electrostatic spray is not applied on bottle):-

1) Area of half cylinder =πr^2+πrh

= (3.14)(4.5)^2+(3.14)(4.5)(18)

= 318.8sqcm

2) Area of sector = πr^2

= (3.14)(4.5)^2

= 63.615sqcm

Total surface area of bottle = Surface area of +Surface area of hemisphere

= 318.8+63.615

= **381.69sqcm**

Case 2 (When electrostatic spray is applied on bottle):-

1) Surface area of cylinder=2πr^2+2πrh

=2(3.14)(4.5)^2+2(3.14)(4.5)(18)

=636.17sqcm

2) Surface area of hemisphere = 2πr^2

=2(3.14)(4.5)^2

=127.23sqcm

Total surface area of bottle = Surface area of cylinder +Surface area of hemisphere

= 636.17+127.23

= **763.4sqcm**

❖ Result Table:

Sr.no	Objects	Without electrostatic field	With electrostatic field
1	Plastic bottle	381.69sqcm	763.4 sq cm

Overall Setup of Electrostatic Spraying System -

Fig.[14] Overall Setup of Electrostatic Spraying System

❖ **Application :**

- **Electrostatic Agriculture Sprayer:-**

  As compare to normal spray it covers maximum area of leaves of the plant and hence the the saving of pesticides is done also productivity incerases.

- **Spray Painting :-**

  Electrostatic spray technology is a new way to apply cleaners, sanitizers, and disinfectants to help facilities treat surfaces, often in less time and with better coverage than traditional cleaning methods. In spray painting particals off paint are give positive charge as they leave the the nozzel of spray gun. The object to be painted is earthed so that there is an electric field between the nozzel and the object.the charged paint droplets follow the field lines are deposited evenly over the surfface of the object.

- **Electrostatic Precititator:-**

  Tiny particals of soot, ash and dust are major components of airborne emmisions from fossil fule burning power plants from many industrial processing plants. Electrostatic precipitators can remove nearly all of this particals from the emissions .the flue gas containing the particals is passed between the series of positively charged metal plates and negatively charged wiers.

- **Photocopier:-**

  An electrostatic copier works by arrenging positive charges in a pattern to be copied on the surface of a nonconducting drum and then gently sprinkling negatively charged drytoner particals on to the drum and are later transerd to the paper and melted to produce the copy.

CHAPTER - 7

CHAPTER 7 - CONCLUSION AND FUTURE SCOPE

Conclusion and Future Scope:

❖ Conclusion :

The electrostatic spraying technology improves productivity as well as efficiency of spraysAnd pestisides,it reduces the exess cost of pestisides and also reduce requirement of water,and it reduce operating cost.

This paper summarized the scientific contributions and innovations during the last decade and discusses the various applications to different fields of agriculture, engineering trends and food processing industry. The emphasis of the review leans towards explanation of physics and description of experimental work, interactions between space charge gradient and electric field produced which in turn can generate instability throughout the bulk of the continuum. It also discussed the interaction between finely divided charged particulate matters and naturally occurring ions present in the atmosphere, leads to neutralization of the charged droplets andhence deteriorates the performance of the spraying system.

❖ Future Scope :

In Future, We can use this electrostatic spray with sensor containing on the top front side of electrode. This electrostatic spray can sense the target object, its size and shape and according to that it sprays the liquid content on the object.

As per the object is small or large according to that reference, sensor electrode, automatic adjust the nozzle valve size and it gives required output. Due to which our whole system get work efficient and gives reliable operation.

For large scale agriculture purpose, electrostatic spray is very time consuming and effort-able. So we can use the microprocessor/PLC based programming for large scale automatic operation. In microprocessor, by programming input we operate whole system and get effortless output.

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