

DESIGN AND FABRICATION OF SOLAR PESTICIDE SPRAYER

Harshit Jain, Nikunj Gangrade, Sumit Paul, Harshal Gangrade, Jishnu Ghosh

Student, Computer Science and Engg., SRM Institute of Science and Technology, Tamil Nadu, India

Student, Computer Science and Engg., SRM Institute of Science and Technology, Tamil Nadu, India

Student, Computer Science and Engg., SRM Institute of Science and Technology, Tamil Nadu, India

Student, Computer Science and Engg., SRM Institute of Science and Technology, Tamil Nadu, India

Student, Computer Science and Engg., SRM Institute of Science and Technology, Tamil Nadu, India

ABSTRACT

Today's energy demand is the great challenge for our society. Conventional energy (Fossil fuel, coal, Nuclear energy etc.) can be widely used in India for various purposes such as Textile industry, Power plant etc. Conventional energy produces a lot of harmful waste that can be harmful to our environment. In such situation we should move towards some non-conventional energy (Solar energy, Wind energy, Tidal energy) sources. It has become very popular for all kinds of development activities such as drying agriculture product, irrigation purpose and for spraying purpose. In this paper we are trying to make unique equipment for cultivation users. Finding solution to meet the energy demand is a great challenge for scientists and engineers. Now-a-days pesticide sprayer is operated based on fuel engine. This operation is more economical. To overcome this, we found out a new concept known as "solar pesticide sprayer". Here, operation of pesticide sprayer is based on solar energy and hence there is no need of any kind of alternative energy source. It has many advantages such as cost of spraying and saving on Fuel/Petrol. There is less vibration as compared to the petrol sprayer. Hence, the system can easily be operated and there is no need of labors which increase the efficiency of farmland.

Keyword: *-Conventional Energy, Solar Energy, Solar Cells, Solar Pesticide Sprayer.*

1. INTRODUCTION

1.1 General

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 trolley based solar sprayer. In our design, we can eliminate the back mounting of sprayer. Ergonomically, it is not good for farmers' health point of view. 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-a-days, there are non-conventional energy sources which are widely used i.e. 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 energy is the light and radiant heat from the sun that influences earth's climate and weather and sustains life. Solar power is sometimes used as a synonym for solar energy or more specifically to refer to electricity generated from solar radiation. Solar radiation along with secondary solar resources such as wind and wave power, hydroelectricity and biomass account for most of the available flow of renewable energy on earth. Solar energy technologies can provide electrical generation by heat engine or photovoltaic means, space heating and cooling in active and passive solar buildings; potable water via distillation and disinfection, day lighting, hot water, thermal energy for cooking and high temperature process heat for industrial purposes. Sunlight can be converted into electricity using photovoltaic (PV), concentrating solar power (CSP), and various experimental technologies, PV has mainly been used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array. A solar cell was constructed by Charles Fritts in the 1880's. Although the prototype selenium cells converted less than 1% of incident light into electricity, both Ernst Werner von Siemens and James Clerk Maxwell recognized the importance of this discovery.

1.2 Solar Energy

The Solar energy is a renewable source of energy which is abundantly available, used for various purpose in form of solar water heater, solar power, and solar cooker. Solar energy is radiant light and heat from the sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy.

1.2.1 Passive Solar Energy

The passive solar system does not involve mechanical devices or the use of conventional energy sources beyond that needed to regulate dampers and other controllers. The passive system is very convenient system and does not involve any complicated design, solar heater and flat solar panels are best example for this system.

1.2.2 Active Solar Energy

The active solar energy system involves external sources like motors and circuits to function the system accurately, the use of mechanical systems for system accuracy and efficiency increase this system is applied. This type of system requires complicated design structures and involve with combination of all engineering like electronics, mechanical, computer science.

1.3 Solar Energy Systems

In Recent years, many of residents around the world used electric solar system as a sub power at their houses. This is because solar energy is an unlimited energy resource, set to become increasingly important in the longer term, for providing electricity and heat energy to the user. Solar energy also has the potential to be the major energy supply in the future. PV cells constituted of semiconductor materials which have the capacity to absorb solar energy and change it into usable electrical.

Energy (the p-n junction directly converts light energy into electricity, directly proportional to the incident radiation). A large quantity of electricity is produced when PV modules are connected in an array configuration. A PV panel as shown in fig.1 produce a constant DC voltage depending on the solar radiation. Generally, power electronics is required at the interface with a micro grid connection, where an inverter changes the DC voltage generated, into a suitable 50Hz AC voltage.



Fig-1: Solar Panels

1.4 Solar cells

A Solar cell is a device which converts the solar energy into electrical energy. This phenomenon is known as Photovoltaic effect.

Solar cells are described as photovoltaic, irrespective of whether the source is sunlight or an artificial light. They are used as a photo detector (for example infrared detectors), detecting light or other electromagnetic radiation near the visible range, or measuring light intensity.



Fig-2: Solar Cell

Solar cells share some of the same processing and manufacturing techniques as other semiconductor devices. However, the stringent requirements for cleanliness and quality control of semiconductor fabrication are more relaxed for solar cells, lowering costs. Polycrystalline silicon wafers are made by wire-sawing block-cast silicon ingots into 180 to 350 micrometer wafers. The wafers are usually lightly p-type-doped. A surface diffusion of n-type dopants is performed on the front side of the wafer. This forms a p-n junction a few hundred nanometers below the surface.

1.5 Pesticides

Pesticides are substances that are meant to control pests or weeds. The term pesticide includes all the following: Herbicide, Insecticide, Insect Growth Regulator, Nematicide, Termiticide, Molluscicide, Piscicide, Avicide, Rodenticide, Predacide, Bactericide, Insect Repellent, Animal Repellent, Antimicrobial, Fungicide, Disinfectant (Anti-microbial), and Sanitizer. The most common of these are Herbicides which account for approximately 80% of all pesticide use. Most pesticides are intended to serve as plant protection products (also known as crop protection products), which in general, protect plants from weeds, Fungi, or insects.

In general, a pesticide is a chemical or biological agent (such as a virus, bacterium, antimicrobial, or disinfectant) that deters, incapacitates, kills, or otherwise discourages pests. Target pests can include insects, plant pathogens, weeds, Molluscs, birds, mammals, fish, nematodes (roundworms), and microbes that destroy property, cause nuisance, or spread disease, or are disease vectors. Although pesticides have benefits, some also have drawbacks, such as potential toxicity to humans and other species. According to the Stockholm Convention on Persistent Organic Pollutants, 9 of the 12 most dangerous and persistent organic chemicals are organochlorine pesticides.

2. LITERATURE SURVEY

2.1 Solar Cell

A solar cell or photovoltaic cell is a wide area electronic device that converts solar energy into electricity by the photovoltaic effect. Photovoltaic is the field of technology and research related to the application of solar cells as solar energy. Sometimes the term solar cell is reserved for devices intended specifically to capture energy from sunlight, while the term photovoltaic cell is used when the source is unspecified. Assemblies of cells are used to make solar modules, or photovoltaic arrays.

2.2 First Generation

First generation cells consist of large-area, high quality and single junction devices. First generation technologies involve high energy and labor inputs which prevent any significant progress in reducing production costs. Single junction silicon devices are approaching the theoretical limiting efficiency of 33% and achieve cost parity with fossil fuel energy generation after a payback period of 5-7 years.

2.3 Second Generation

Second generation materials have been developed to address energy requirements and production costs of solar cells. Alternative manufacturing techniques such as vapor deposition and electroplating are advantageous as they reduce high temperature processing significantly. It is commonly accepted that as manufacturing techniques evolve production costs will be dominated by constituent material requirements, whether this be a silicon substrate, or glass cover. Such processes can bring costs down to a little under but because of the defects inherent in the lower quality processing methods, have much reduced efficiencies compared to First Generation. The most successful second-generation materials have been cadmium telluride (CdTe), copper indium gallium selenide, as glass or ceramics reducing material mass and therefore costs. These technologies do hold promise of higher conversion efficiencies, particularly CIGS-CIS, DSC and CdTe offers significantly cheaper production costs. In CdTe production represented 4.7% of total market share, thin-film silicon 5.2% and CIGS 0.5%.

2.4 Third Generation

Third generation technologies aim to enhance poor electrical performance of second generation (thin-film technologies) while maintaining very low production costs. Current research is targeting conversion efficiencies of 30-60% while retaining low cost materials and manufacturing techniques. They can exceed the theoretical solar conversion efficiency limit for a single energy threshold material; which was calculated in 1961 by Shockley and Queasier as 31% under 1 sun illumination and 40.8% under maximal concentration of sunlight (46,200 suns, which makes the latter limit more difficult to approach than the former).

2.5 Objective

Solar photovoltaic (PV) systems have shown their potential in rural electrification projects around the world, especially concerning Solar Home Systems. With continuing price decreases of PV systems, other applications are becoming economically attractive and experience is gained with the use of PV in such areas as social and communal services, agriculture and other productive activities, which can have a significant impact on rural development. There is still a lack of information, however, on the potential and limitations of such PV applications. The main aim of this study is, therefore, to contribute to a better understanding of the potential impact and of the limitations of PV systems on sustainable agriculture and rural development (SARD), especially concerning income-generating activities.

Energy demand is one of the major threads for our country. Finding solution to meet the energy demand is great challenge for Scientist, Engineers. Now a day pesticide sprayer is operated based on fuel engine. This operation is more economical. To overcome this, we found the new concept known as "Solar Pesticide Sprayer." In this pesticide sprayer is operated mainly based on solar energy and hence there is no need of any kind of alternative source. It has many advantages such as cost of spraying and saving on Fuel/Petrol. There is less vibration as compared to the petrol sprayer. Hence the system can be easily operated there is no need of labors which increases the efficiency of farmers. Solar based pesticide sprayer is one of the improved model of pesticide sprayer pumps. Sun is the source of all energy on the earth. It is most abundant, inexhaustible and universal source of energy. All other sources of

energy draw their strength from the sun. India is blessed with plenty of solar energy because most parts of the country receive bright sunshine throughout the year except a brief monsoon period.

The yield decreases due to the presence of pests, insects in the farms. To kill the pests, insect's pesticides, fertilizers are sprayed either manually or by using sprayers. Earlier, the pesticides and fertilizers were sprinkled manually, but they will result in harmful effects on farmers. To overcome this problem, Different spraying techniques have been developed. These sprayers consist of different mechanisms and the cost of equipment is generally high. We developed a mechanism in which we tried to minimize the equipment cost by removing the pump to spray. This Sprayer works on Bernoulli's principle, in which the spraying action of the sprayer is due to the head developed and mechanical linkage. The model is developed mathematically for the major components like tank, required head and the spring mechanism.

3. PROBLEM STATEMENT

The research taken for improving the efficiency of solar power system was based on the material improvements by changing its doping level and finding alternate material showing good efficiency but the heat was causing main problem in system efficiency. The material was able to produce the current and voltage in response to light showed an efficiency of 14% but when the cells are mounted onto the system due to overheating the system showed less efficiency, to reduce heat new system needs to be developed.

Agricultural sprayer vehicle should be able to work with help of appropriate controls to spray effectively along the path as required to perform the required functions. Based on these factor, the basic mechanical designs of agricultural sprayers vehicle will be designed and implemented for 3 liters of payloads by combining all the factor such as stated above with goal of achieving a better functionality.

The droplets are deposited principally on the nearest earthed surface, penetration through a crop canopy is limited. However, in some circumstances this factor can also be advantageous as contamination of the soil under the crop is significantly reduced, so that some natural enemies can be less effected. Some spray drift can occur, but in most situations, downwind movement of spray is significantly reduced. This reduction in drift makes the technique particularly suited to small scale farmer who may grow certain types of crops.

Normal maintenance jobs include cleaning the equipment and applying necessary lubricating oils and greases to the rubbing and moving parts. If this normal maintenance is neglected the machine gets rusted and moving parts wear out quickly resulting in loss of efficiency, frequent replacement of spare parts and finally uneconomical working.

Besides the normal maintenance as above, special care must be taken for maintaining the plant protection equipment. The pesticide formulations are chemically aggressive on metals, etc. The cleaning and washing of the chemical tank, discharge lines, nozzles, etc., are to be done regularly after the day's spraying work is completed otherwise the residues of chemicals used for spraying acts on the parts and causes corrosion and deterioration of materials.

If this aspect of thorough cleaning is not done on the plant protection machine, even though it is made of with high standard materials, it will not serve its normal life and would lead to premature condemnation.

1. Cleaning the chemical tanks, hoses, valves and nozzles etc. and flushing sufficiently to avoid pesticide residue which is corrosive.
2. Cleaning the machine equally well from outside also as it is contaminated due to leakage, spilling of pesticide.
3. Lubricating suitably the pump parts like piston, cylinder, valves and other rotating, sliding, moving parts.
4. Store the machine in dry place duly protected from sun and rain.

4. METHODOLOGY

Design and fabrication of solar powered pesticide sprayer has following steps, Selection of components. The selection of component has been done according to the requirements. Solar energy obtained by the sun is converted into electrical energy using solar panel by photovoltaic effect. The output of the energy conversion is given to charge a deep cycle lead acid battery through a charge controller. The charge controller limits the rate at which electric current is added to the battery. Preventing overcharging and protecting against over voltage. It employs the Pulse Width Modulation (PWM) technique which gradually stops charging the battery, the main advantage of PWM is that the power loss in the switching device is very low. The output from the charge controller is given to the battery by a 3-pin socket through an electrical network.

1. O state

In this state, the switch is off. The circuit is in the dead state but the battery will be charged through the plug.

2. I state

In this state, the 2nd part of the circuit is switched on (12V). Hence, there is no current flowing through the connecting wire, here the plug charges the battery but the motor does not run.

3. II state

In this state, the switch is turned to I. Thus, the entire circuit is switched on. The motor operates while there is simultaneous charging of the battery through the plug. The value of the variable resistance controls the motor's RPM. The output of the dc motor is used to actuate the diaphragm of the diaphragm pump for pumping the fluid.

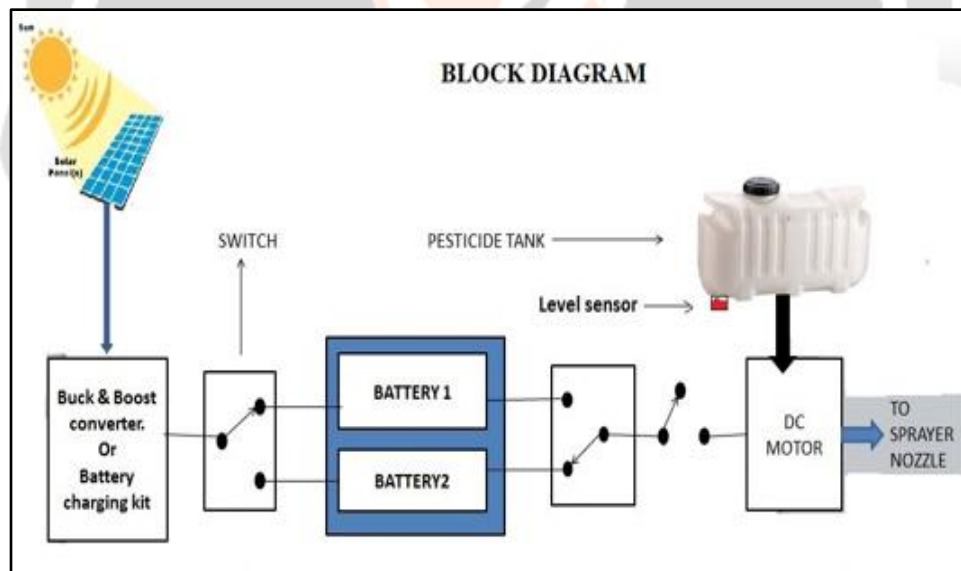


Fig-3: Block Diagram

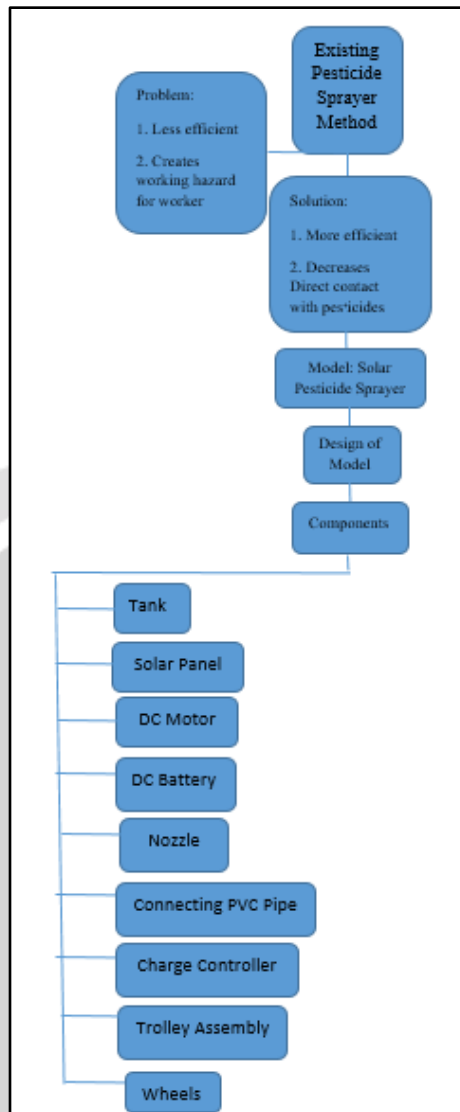


Fig -4: Flow Chart

5. CONSTRUCTION

In this project an aluminum frame is constructed using aluminum bars to keep the weight of the frame low. In this frame a retractable link is fixed to the top end of which a solar photovoltaic panel is fixed that converts solar power into electricity. This electricity is then provided to battery via a charging circuit and is used for charging the battery. Electric power from this battery is given to an electric motor via control switches. By continuously feeding the insecticide to the blower pipe the same is spread or sprinkled where we wished. Liquid insecticide is sprayed on the crops using spray pipe which receives liquid from a reservoir with the help of a pump. This pump is driven by another DC motor that receives power from the same battery. Thus, insecticide in liquid form is sprayed where we wished.

This works on solar energy. The concoction is accomplished by the use of solar panel, a centrifugal pump which runs on dc supply is attached to the solar panel the solar panel generates the power that power is dc power its positive and negative charges are connected to a batter to save the power and use it when the sun rays are not present by using this device we can spray pest ices to the herbs and plants and any agriculture spraying it is

economical as compared to the other means used like petrol/diesel pesticides sprayers. There is no much maintenance cost and no operating cost as it is using solar energy it is free of cost and there is no pollution its working principal is very simple and the it is economical of the farmers which has one more advantage that it can also generate power that power is saved in the battery and it can be used for both for spraying and well as to light in the house when there is no current supply. And where as in rainy season when the sun rays are not there that time we can charge the battery and use it to spray pesticides to the herbs and plants as compared to petrol/ diesel it is economical no efforts to human just he must carry the device the device is light in weight so it is much feasible.

The main components used to fabricate the model are:

- Solar panel
- Pump
- DC motor
- Battery
- Tank
- Nozzle

6. DESIGN AND CALCULATIONS

6.1 Calculation

To compete with the existing product in the market, we have limited the budget of our system. Attempt was made to modify the design of the existing conventional spraying setup to meet the standard quality requirements.

The principle of REVERSE ENGINEERING was adopted for the design of our solar powered spray pump system
A.Coverage of area during spraying.

Assumptions:

1. The height of the delivery pipe containing nozzle is in the range of 0.60 to 0.90 m above the ground and it is held horizontally.
2. The coverage area is in the form of sector of a circle whose path is controlled by operator.
3. The clearance angle of the sector covered during spraying is 5° on both the sides.
4. Actual area is lesser than the calculated area by 10%.
5. Cross section of nozzle is circular.
6. The portion of pipe containing the nozzle is held horizontal to the ground.
7. The discharge out of the nozzle is in the form of finely atomized particles performing projectile motion.

S. No	Parts	Specification
1	Tank	PVC, 16 lit, 1 kg
2	Solar Panel	20W PV solar panel Dimension: 49×35×3 cm Weight :2 kg Max voltage: 17 V Max current: 1.18 A Open circuit volt: 21 V Short circuit current: 1.2 A Tolerance: ± 5%
3	Battery	Sealed Lead Acid battery Capacity: 12 V, 9 Ah Dimensions: 15×9×6 cm Weight: 2.5 kg Constant voltage charge with regulation Standby use: 13.5 V- 13.8 V Cycle use: 14.5 V – 14.9 V Max initial current: 2.4 A
4	Motor	Brushless DC motor Capacity :12 V, 2.2 A RPM :0-6000
5	Diaphragm Pump	Dimensions: 17×6×6 cm Weight: 550 gm Max discharge :3 ltr/min Max pressure: 80 psi In built operating pressure switch to cut off the pump from the motor.
6	Pipe	Diameter:11 mm Length: 2 m

Table -1: Parts and Specification

6.2 Design

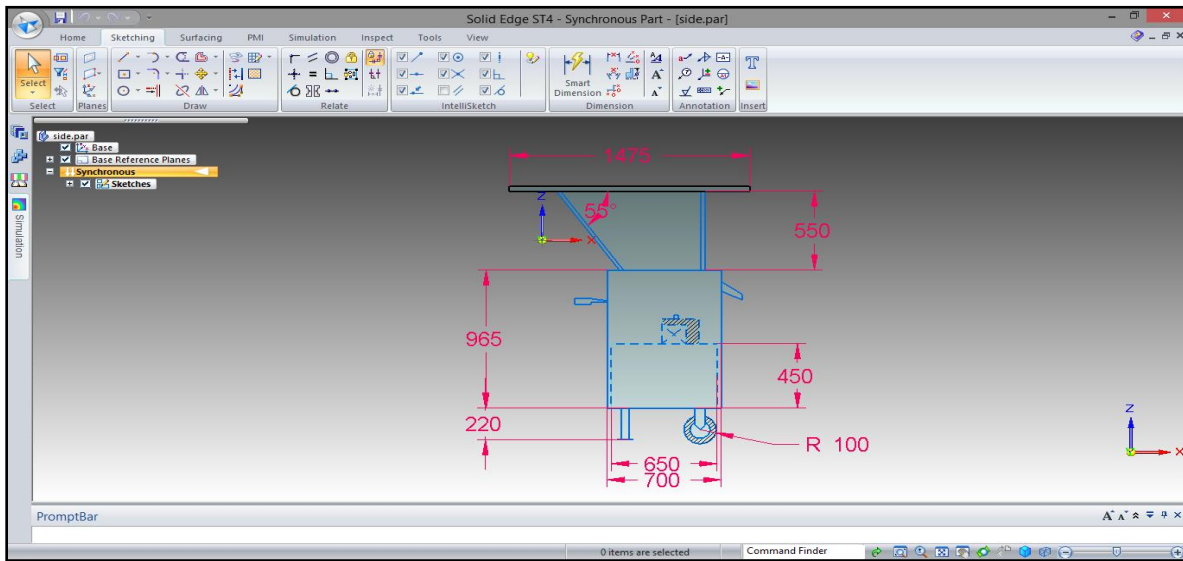


Fig-5: 2D View (a) Side View

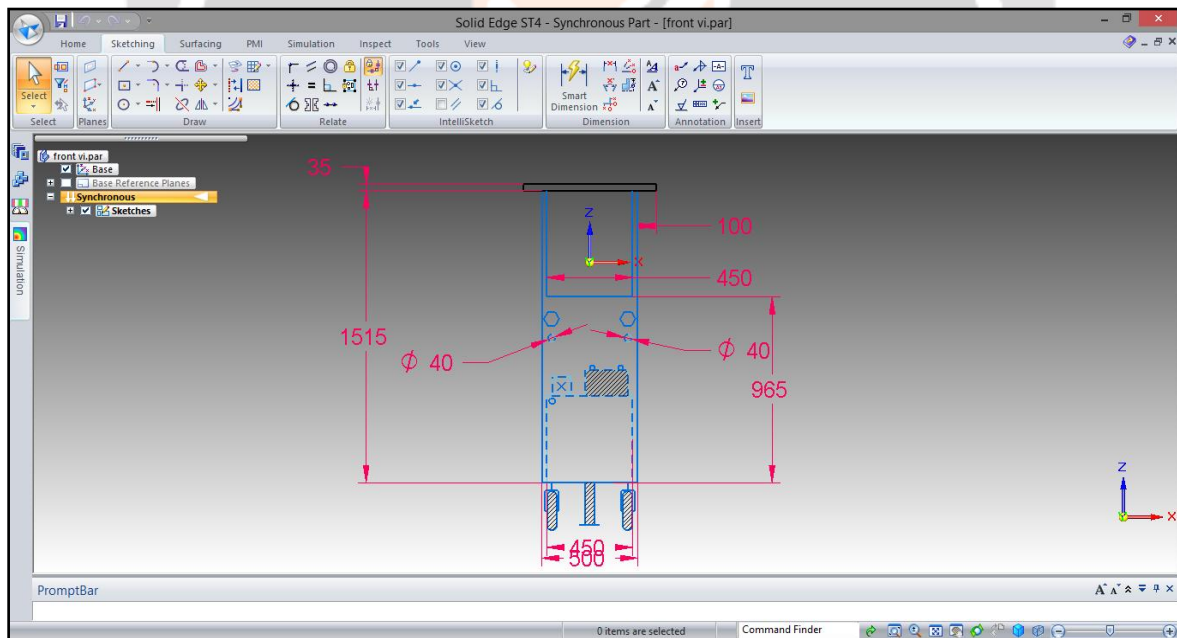


Fig-6: 2D View (b) Front View

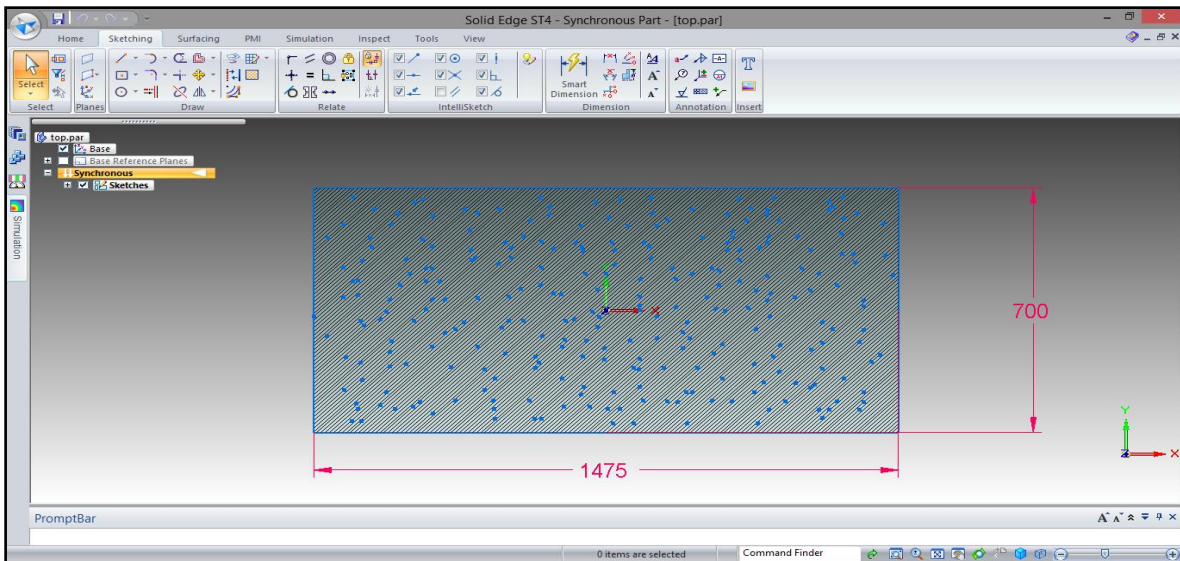


Fig-7: 2D View (c) Top View

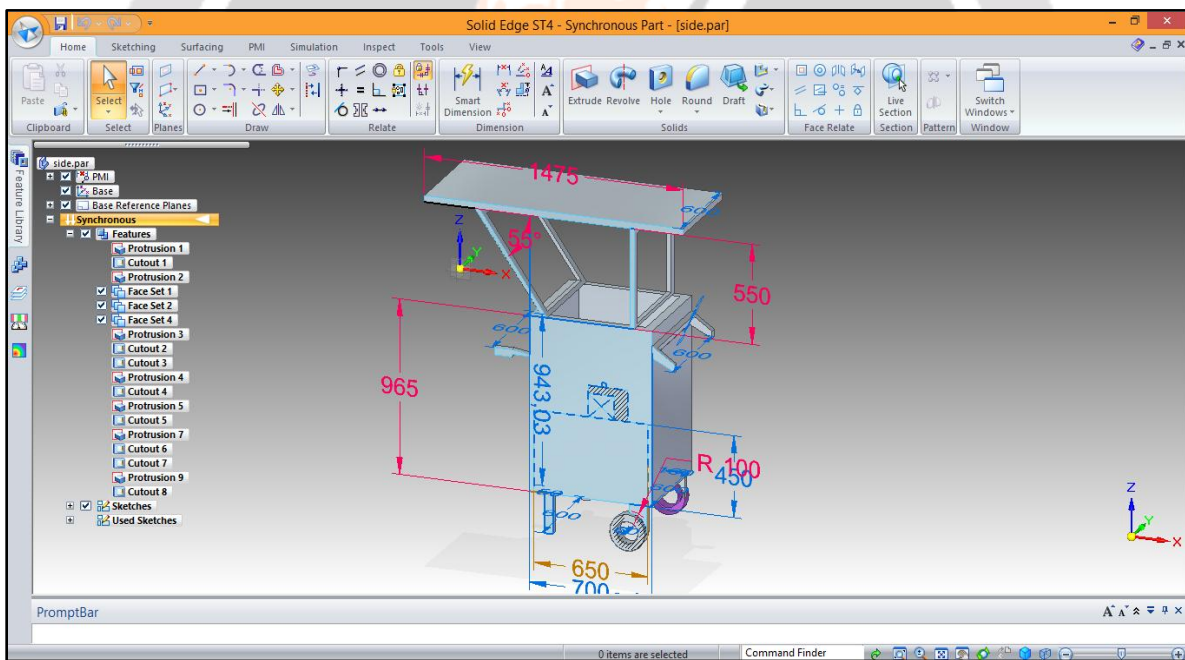


Fig-8: 3D View (a) Isometric View

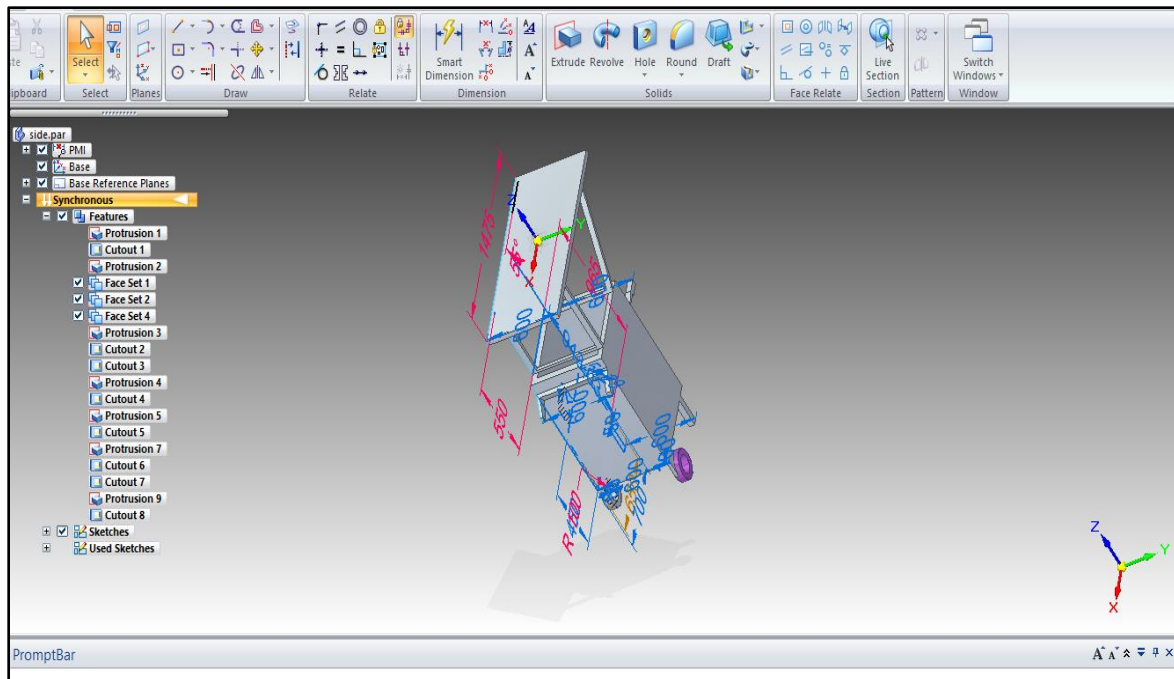


Fig-9: 3D View (b) Discrete View

7. ADVANTAGES AND DISADVANTAGES

7.1 Advantages

1. Solar-powered pesticide systems are practical in flat terrain where the sun shines.
2. Solar-powered pesticide pumps can be placed in or next to the pond or other source of pesticide and the pesticide can be pumped where it is needed.
3. Solar pesticide pumping is clean and efficient.
4. Solar electric water pumping cuts down on waste because it's based on natural cycles. Your panels give the most pumping power on the sunniest days---when you need the most pesticide.
5. Solar power is clean. You never have to worry about polluting.
6. Solar-powered pesticide systems take very little maintenance because they only have a few moving parts. They have long life, usually 20 to 40 years. And solar pesticide systems never run out of fuel if the sun is shining.

7.2 Disadvantages

1. Relatively high initial cost.
2. Lower output in cloudy weather.

8. RESULT AND DISCUSSION

Based on the experimentation, it is found in this project that the Solar panel provides 12V, 1A during day time between 9.30 AM to 4.30 PM. Since the pesticide sprayers are used in this duration, testing is as carried out in this time. The 12V, 8Ah battery can be charged fully in 7 hours during this time at 1.3A. Hence this module can be operated to spray continuously 7 to 8 hour which is not possible with electrical pesticide sprayer. The model cost will not exceed Rs.7000. Hence the proposed model is cost effective and compatible with other models available commercially.

9. CONCLUSION

It is observed that, this model of solar powered pesticide sprayer 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 convention sprayer. As India is a developing country, this product can be become more popular in rural areas.

10. FUTURE SCOPE

1. Future scope of this type of sprayer are very bright because it is very useful in agriculture and reduce the workload.
2. It reduces the time consumed in spraying the pesticide liquid and work very effectively.
3. It will help the farmers to do work in any terrain, season and conditions.
4. It will reduce the danger for the farmers from different breathing and physical problems.

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