STUDIES AND ANALYSIS OF A SOLAR-POWERED PESTICIDE SPRAYER

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ABSTRACT

This article delves into the development and analysis of hand sprayers utilizing non-traditional energy sources, with a specific focus on a solar-powered sprinkler pump. The primary objective is to address the agricultural needs in remote areas where fuel accessibility is a challenge. The article explores the design, components, and operational principles of the solar sprayer, emphasizing its advantages, such as simplicity, cost-effectiveness, and environmental friendliness.

The study critically evaluates the drawbacks of conventional manually operated sprayers, highlighting limitations in capacity, operator fatigue, and the dependency on operator skill. Weather dependency, potential chemical exposure, and maintenance challenges are also discussed, providing a comprehensive overview of the existing issues with manual knapsack sprayers.

It details the operational workflow of the solar sprayer and the associated benefits, emphasizing its potential to revolutionize agricultural practices.

In conclusion, the article suggests the transition to solar-powered boom sprayers for enhanced efficiency and resource utilization in both small and large agricultural areas. The integration of innovative, eco-friendly technologies is seen as a key factor in increasing agricultural production efficiency while minimizing environmental impact.

Key words: spraying, agriculture, plant protection, boom sprayer, spraying, solar energy.

INTRODUCTION

As we know, the majority of the population of many countries live in villages, and their main occupation is agriculture. The main goal of this project is to study and analyze hand sprayers using non-traditional energy sources.

Thus, a solar-powered sprinkler pump will help farmers in those remote areas of the country where fuel is not easy to get. They can do their normal job, as well as significantly save fuel. At the same time, they reduce environmental pollution. Thus, government revenues are saved, as well as the most in-demand fuel [1-3].

On many Internet sites and magazines, we often see manually operated sprayers. Everyone knows that such sprayers, due to their low cost, soon became popular. Below we will examine a similar sprayer and analyze it (Fig.1). Because we will analyze that these devices have a number of other disadvantages, since they are cheap in price.

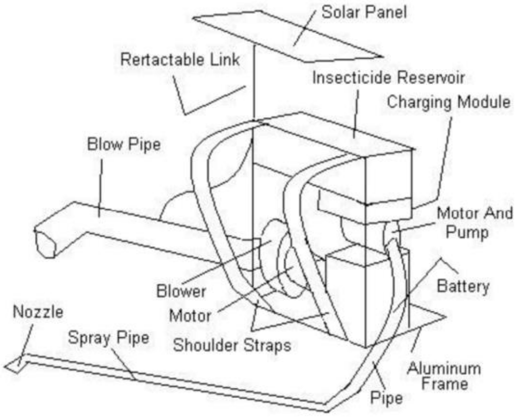

Figure 1. Selected sample spray for study and analysis

This unit is made of parts such as a spray liquid tank, spray pipe, solar panel, battery, charger, pump, motor, etc.

In this project, an aluminum structure is assembled utilizing aluminum bars to maintain a lightweight design. Within this structure, a retractable linkage is affixed, and at its upper extremity, a solar photovoltaic panel is installed to convert solar energy into electricity. The generated electricity is then directed to a battery through a charging circuit, serving the purpose of recharging the battery. The electric power stored in this battery is subsequently supplied to an electric motor through control switches, providing control over the entire device. A blower fan is connected to the shaft of this electric motor, facilitating the forceful discharge of air into the blower pipe [4].

The operator holds the blower pipe by hand, directing the high-speed air to the desired area for pesticide or insecticide application. The insecticide reservoir is linked to the blower pipe, continuously delivering the insecticide to be dispersed or sprinkled as needed. Liquid insecticide is sprayed onto crops using a spray pipe, drawing liquid from a reservoir with the assistance of a pump. Another DC motor powers this pump, receiving its energy from the same battery. Moreover, the project has the capability to operate an emergency lamp using battery power, making it particularly useful and advantageous for farmers. Importantly, the operational expenses of the project are nonexistent.

Specification of this device.

The selection of the spray motor is based on the spraying capacity and discharge capacity, with the motor weighing approximately 1 kg and requiring 7 amps of current. The operational power needed is 84 watts, and it operates at 12V with a motor speed of 1,600 rpm. The discharge capacity ranges from 0 to 12 liters per minute, with a flow rate exceeding 560 ml in 10 seconds. The fluid pressure is 1.6 kgf/cm2.

The choice of the battery is determined by the operating power of the motor. The battery weighs 2 kg. It has an output power of 144 watts and operates at 12V.

The selection of the solar panel is based on the output power of the battery. The solar panel has a power of 10 watts, dimensions of 397*278*25 mm, and weighs 1.6 kg. It operates with an open circuit voltage of 21.5 volts, a short circuit current of 0.65 Amp, and an operating current of 12 Amp.

Working of Solar Sprayer.

The operational principle of the solar sprayer is based on the direct conversion of solar radiation into electricity through semiconductor devices known as Photovoltaic (PV) cells. When sunlight interacts with the solar cell, a portion of the light is absorbed and converted into electrical energy. This energy is stored in a lead-acid battery. A 12V DC motor, connected to the battery, then transforms the electrical energy into mechanical energy.

Charging is facilitated by a solar panel, allowing continuous battery charging during discharge by attaching the panel to the sprayers. Discharge can last for a minimum of 4 to 5 hours without the panel. If a longer operation is required, the battery can be changed, or a separate solar panel attachment can be used for charging.

The solar agro sprayer comprises three main components: the solar panel unit, the storage battery unit, and the rotating motor. In this design, the traditional two-stroke petrol engine of a power sprayer is replaced with a combination of a storage battery and a rotating motor, controlled by an attached switch. A 75-watt solar panel is mounted on a circular frame above a 10-liter cylindrical chemical tank at a 45° angle to ensure optimal exposure to solar radiation during field operation.

The solar panel is connected in parallel with a 12V storage battery, which stores the collected electrical energy. The battery, in turn, powers a 12V DC motor attached to the frame. The motor's operation is regulated by a press-type switch on the assembly, allowing the stored electrical energy to be converted into mechanical energy without the need for conventional fuels like petrol and oil.

The operation of the pump is straightforward. The solar panel collects solar energy, converts it into electricity, and supplies it to the battery. The battery charges itself using this electricity, subsequently powering the motor and lighting system. The motor, located at the tank's bottom, draws liquid from the tank and delivers it through a delivery pipe. The spray gun's 'ON' and 'OFF' functions are controlled by a handle, with a switch enabling the motor's operation as the handle is pushed, allowing the motor to suction liquid and deliver it through the delivery pipe.

Analytical calculation of battery current and charging time

To determine the current generated by the solar panel, denoted as I, analytical calculations were employed using the maximum power (P) output of the solar panel and the voltage rating (V) of the battery. This relationship is expressed as I = P/V. In this case, with a solar panel power output of 10 watts and a battery voltage rating of 12V, the current (I) is calculated as I = 10/12 = 0.83 Ampere.

The charging time (T) for the battery was then calculated by considering the ratio of the battery's ampere-hour rating to the total current consumed by the solar panel. Mathematically, this is represented as T = (battery rating in ampere-hour)/(total current consumed by the solar panel). Substituting the values, the charging time is determined as T = 12/0.83 = 14.45 hours.

In summary, the analytical calculations reveal that the current generated by the solar panel is 0.83 Ampere, and the charging time required for the battery is estimated to be approximately 14.45 hours, taking into account the specified parameters and ratings.

Advantages

Frequently, the creators or authors of the article highlight the numerous benefits associated with this invention. They emphasize its straightforward design, marking it as a system characterized by simplicity. Additionally, the device is touted for its cost-effectiveness, presenting an economic alternative. Maintenance is simplified as the apparatus is easy to clean and upkeep, reducing potential operational complexities.

An especially noteworthy advantage underscored by the inventors is its reliance on renewable energy. This feature aligns with sustainability principles, positioning the device as an environmentally friendly solution. The absence of air pollution and noise during its operation further contributes to its appeal. The ease of handling the device is accentuated, enhancing its user-friendliness. Importantly, the device operates without the need for traditional fuel, resulting in a substantial reduction in the overall cost associated with the spraying process. Collectively, these advantages position the device as an innovative, efficient, and environmentally conscious solution in the domain it serves.

Shortcomings and detriments of manual knapsack sprayer.

Despite the mentioned advantages, it is essential to acknowledge certain drawbacks associated with manual knapsack sprayers that inventors or authors may not explicitly mention:

1. Limited Capacity and Coverage: Manual knapsack sprayers typically have limited tank capacity, necessitating frequent refills, which can be time-consuming and interrupt the spraying process. The limited coverage may not be suitable for large-scale agricultural operations.

2. Physical Strain and Fatigue: The manual operation of these knapsack sprayers can lead to physical strain and fatigue, especially during prolonged use. This aspect may pose challenges for users, impacting both efficiency and the well-being of the operator.

3. Dependency on Operator Skill: Effectiveness often relies heavily on the skill and experience of the operator. Inexperienced users may struggle to achieve uniform coverage, leading to uneven distribution of pesticides or fertilizers.

4. Risk of Overuse or Underuse: Manual control increases the risk of overuse or underuse of spraying substances, potentially impacting the desired efficacy of pest control or crop fertilization.

5. Limited Precision: Achieving precision in spray application can be challenging with manual sprayers, potentially resulting in unintentional overspray onto non-target areas or insufficient coverage on the intended surface.

6. Weather Dependency: The efficiency of manual knapsack sprayers may be influenced by weather conditions such as wind. Wind can lead to drift, causing the sprayed substances to deviate from the target area and potentially harm neighboring crops, ecosystems, or individuals.

7. Potential Chemical Exposure: Operators using manual sprayers may be exposed to the chemicals being sprayed, especially if adequate protective measures are not taken. This exposure can pose health risks to the operator.

8. Maintenance Challenges: While simplicity is often touted as an advantage, it can also translate to a lack of sophisticated features for troubleshooting or self-maintenance. Issues with parts or mechanisms may require technical expertise for resolution.

9. Environmental Impact of Chemicals: Though the device itself may be deemed eco-friendly, the chemicals used in the sprayer may have environmental implications. Their impact on soil, water, and non-target organisms must be considered in the broader context.

10. Ineffective Against Certain Pests: Manual sprayers may not be as effective against specific pests or diseases that require more targeted or specialized treatment methods.

In weighing the pros and cons, users should carefully consider their specific needs, operational scale, and environmental concerns before opting for a manual backpack sprayer.

CONCLUSIONS

The introduction of the proposed solar-powered electric sprayer in the republic will allow to switch from organic fuel to directly transferring the agrotechnical measures to mobile electric-powered technical means that are charged in the field itself in small-sized fields.

This in turn provides the opportunity to carry out a number of agrotechnical measures related to plant spraying in a short time, at low costs, and to use the existing technical and material resources efficiently.

The introduction of new innovative, resource-saving technologies and equipment to the republic's agriculture will increase the production efficiency.

In turn, instead of the backpack sprayers mentioned above, it is recommended to use boom sprayers powered by solar panels [5-7].

Their use is very convenient for agricultural processing of small and large areas of land. In this case, it will be possible to effectively use the workforce, the health of workers will not be affected, fuel resources will not be used, money spent on production can be significantly saved, there will also be no atmospheric pollution, etc.

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