Solar Outdoor Air Purifier

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***Abstract*—Air pollution occurs when harmful or excessive quantities of substances including gases, particles, and biological molecules are introduced into Earth's atmosphere. It may cause diseases, allergies and even death to humans; it may also cause harm to other living organisms such as animals and food crops, and may damage the natural or built environment. Both human activity and natural processes can generate air pollution. Indoor air pollution and poor urban air quality are listed as two of the world's worst toxic pollution problems in the 2008 Blacksmith Institute World's Worst Polluted Places report. Outdoor air pollution alone causes 2.1 to 4.21 million premature deaths annually. According to the 2014 World Health Organization report, air pollution in 2012 caused the deaths of around 7 million people worldwide, an estimate roughly echoed by the International Energy Agency. Though government is taking several measures to control air pollution it is rising rapidly due to urbanization, excessive usage of automobiles, factories, construction works., etc., As we cannot deny the fact that development without transport, infrastructure and factories is not possible. We have to search for alternate means of air pollution reduction. However, air purification /filtration requires lot of energy to drive induced air fans it is better to use solar energy rather than going for conventional thermal energy. As a part of our project dissertation, we are planning to fabricate a solar air purification system for reduction of air pollution.**

***Index Terms*—Air Pollution, Filter, Solar Panel, Atmosphere**

I. INTRODUCTION

As we know that air pollution level in cities is very high. Most of pollution comes as by-product from vehicle and construction of buildings; these are in form of particulate matter which is like methane, carbon dioxide, dust particulate etc. These create a lot of health problems like respiratory illness, decreased lung functions, development of diseases like asthma etc. Larger dust particles are major particulate among these and if its air quality value are down to minimum then air has very improved quality in which all type of living things can breathe easily. Although there are many types of air purifier that are available in market but none of them are sufficient enough to deliver its working efficiency in public places like bus stand, near hospitals, traffic signals etc. Many institutes are also not able to afford these because of high cost and installation cost. Government organizations have very low budget for air purifier like extra expenditure. So, it is advisable to develop such air purifier which can cost less and are highly efficient. So, we are making solar powered air purifier, which runs on solar energy without use of filters and also works for longer duration than others. It uses component like solar panel, fan, converter, pump, etc. suspended particulates (TSP)), based on an exploratory study. Initially, a protocol was developed to standardize the construction site selection criteria, laboratory procedures, field sample collection and laboratory analysis.

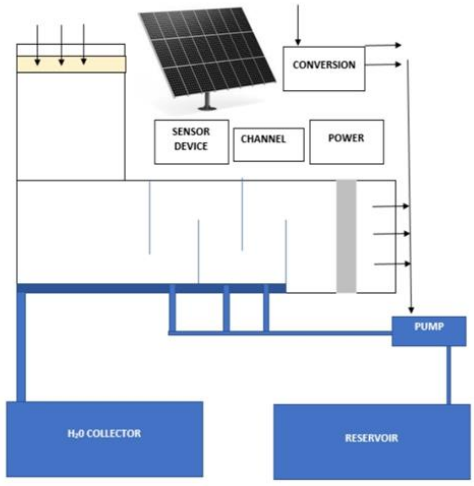

Fig.1.1 Introduction about Solar outdoor air purifier

II. LITERATURE REVIEW

[1] National Air Quality Index

The familiarity of step-by-step levels of contamination is imperative to the people, particularly for those that experience the evil impacts of diseases done by receptiveness to defilement. Further, the accomplishment of a nation is to refine the environment the people World Health Organization have taken steps to reduce the pollution and meanwhile to improve the quality of living in the cities as well. As a result, a straightforward any rated incredible correspondence of air quality is fundamental thing that is needed. At the beginning the Air Quality Index (AQI) changes the weighted potential gains of individual defilement related limits (Example: SO2, CO, detectable quality, etc) into one grouping of different numbers which is in wide use for checking the air quality ratio and having better mental cycle for people among different countries.

[2] Air Particles in Work Area and its Characteristics

The distinguishing proof and portrayal of particulate (PM) fixations from development site exercises cause significant moves on account of the fluctuated qualities related with totally various angles, similar to focus, molecule size and molecule creation. Additionally, the portrayal of particulate is impacted by natural condition, along with temperature, dampness, destruction. It consists of components that are for extensive testing and to make a procedure to reduce the particulate pollution and reduce blow-off in the air. The particles that remain in the air is also cleared. The objective of this paper is to spot and portray the PM outflows on a development site with totally various mechanics distances across (PM2.5, PM10, all out suspended particulates (TSP)), supported associate in nursing beta study. At first, a convention was created to normalize the improvement site decision rules, lab systems, field test grouping and lab investigation.

III. METHODOLOGY

A solar-powered outdoor air purifier is designed to improve air quality in outdoor spaces by using solar energy as a power source. Here's a breakdown of the typical methodology for such a device:

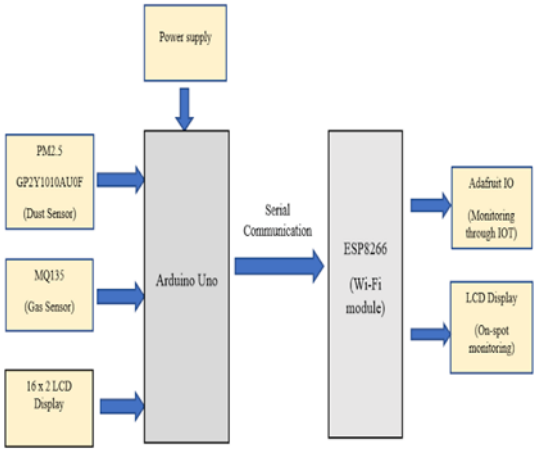

Fig.1.2 Solar outdoor air purifier with air quality monitor

1. Power Supply

•Solar Panel Array**:** The system relies on solar panels to convert sunlight into electrical energy. These panels are typically mounted on top of the purifier or nearby. Battery Storage: Since solar energy is not available at night or during cloudy conditions, the purifier is usually equipped with batteries to store excess energy generated during the day for continuous operation.

2. Air Filtration Process

•Air Intake: The purifier pulls in surrounding air through fans powered by the solar-generated electricity. The air is directed into the filtration system. Filtration Stages: Multi-stage filtration is employed to remove pollutants, including particulate matter (PM2.5, PM10), gases (NOx, SOx), and volatile organic compounds (VOCs).

•Pre-Filters: Captures larger particles, such as dust and pollen, extending the life of more specialized filters.

•HEPA Filters**:** High-efficiency particulate air filters trap finer particles, such as PM2.5, which are common in outdoor pollution.

• Activated Carbon Filters**:** Removes gases and VOCs through adsorption, tackling urban pollutants.

•Photocatalytic Oxidation (PCO): Some purifiers use PCO to break down smaller pollutants. This involves using UV light (from LEDs) to activate a catalyst (often titanium dioxide), which then reacts with pollutants, breaking them down into harmless substances like carbon dioxide and water.

3. Airflow and Circulation

•Fan System: Solar-powered fans facilitate consistent airflow through the device, ensuring that polluted air is drawn in and purified air is expelled.

Directional Ventilation: The purified air is often directed back into the surrounding environment, maintaining air circulation in outdoor spaces.

•Advantages and Challenges

Advantages: Renewable energy use, autonomy in off-grid areas, and real-time air quality monitoring.

Challenges: High initial cost, effectiveness dependent on weather and sunlight, and potential maintenance complexity in high-pollution areas.

This methodology helps make outdoor spaces healthier, especially in urban environments, by reducing pollutants using clean solar energy.

IV. STRUCTURAL COMPONENTS OF SOLAR OUTDOOR AIR PURIFIER

A solar outdoor air purifier uses solar power to drive the air filtration system, making it eco-friendly and self-sustaining. Here are the key structural components:

1. Solar Panel

Captures sunlight and converts it into electricity to power the purifier. Usually mounted on the top or sides of the purifier, angled to maximize sun exposure.

2. Battery Storage

Stores excess solar energy for use when sunlight is insufficient, such as at night or on cloudy days. Ensures continuous operation and reliability of the purifier.

3. Air Intake and Outlet

Air Intake: Allows polluted air to enter the purifier. Often designed with filters to trap larger particles like dust or leaves.

Air Outlet: Releases the purified air back into the environment. May include vents or diffusers for even air distribution.

4. Filtration System

Pre-filters: Trap larger particles, dust, and debris.

HEPA Filters: Capture fine particles, including allergens and PM2.5 pollutants.

Activated Carbon Filters: Remove gases, odors, and VOCs (Volatile Organic Compounds).

Photocatalytic Filters (Optional): Use light to activate a chemical reaction that neutralizes harmful compounds.

5. UV-C Light (Optional)

Emits ultraviolet light to kill bacteria, viruses, and mold spores, adding a layer of disinfection. Often used in tandem with other filtration methods for more comprehensive purification.

6. Air Circulation Fan

Draws air into the purifier and pushes it through the filters and UV-C chamber. Powered by the solar panel and/or battery storage, it regulates airflow through the purifier.

7. Control System and Sensors

Air Quality Sensors: Measure pollutant levels (e.g., PM2.5, PM10) to adjust fan speed and filtration modes.

Control Circuit/Board: Manages power flow, adjusts operation modes, and displays real-time data (if available).

On/Off Switch and Power Indicator: For user control and operation monitoring.

8. Housing/Enclosure

Durable, weatherproof casing that protects internal components from the elements (rain, dust, heat).Often made from corrosion-resistant materials to ensure long-term outdoor use.These components work together to purify the air using sustainable solar energy, ideal for outdoor environments such as parks, streets, and industrial areas.

Fig.1.3 Solar outdoor air purifier

V. DIFFERENT COMPONENTS OF PROJECT:

1. C- Chamber

The chamber consists of a piece of the air device where the polluted air from the setting is sucked into the chamber utilizing a fan.

2. Atomizer

The splash is utilized to change over water into awfully fine drops. There region unit 2 atomizers inside the air decontamination framework.

3. Pump

A pump is introduced in the gadget. The water is pumped out at high pressing factor and provided through the lines into the atomizers.

4.Fan

A 750 RPM fan is introduced at the vent of the gadget. This fan has two ramifications that are to suck dirtied air from the delta climate into the chamber and furthermore to stream away the perfect air into the power source climate.

5. Solar Power System

There is partner degree establishment of a 100-watt sun-based exhibit. This board is utilized to supply power from radiation of sunrays.

VI. CHALLENGES AND INNOVATIONS

Creating an effective solar-powered outdoor air purifier presents unique challenges and requires significant innovation. Here are some key challenges and potential solutions:

1. Energy Efficiency and Storage

Challenge: Solar energy varies by time of day and weather, which limits the energy available for continuous purification. Efficient storage is necessary to ensure the purifier works consistently.

Innovation: Using advanced battery technology, like lithium iron phosphate or solid-state batteries, for longer life and faster charging.

2. Purification Effectiveness

Challenge: Outdoor air has a high volume of pollutants spread across vast areas, making localized purification difficult.

Innovation: Combining filtration with photocatalytic oxidation, which uses UV light to break down pollutants, can increase purification efficiency. Some systems even incorporate moss or other plants to help capture and metabolize pollutants, a more sustainable and natural approach.

3. Scalability and Mobility

Challenge: Traditional air purifiers are often stationary and require large installations, making them less effective over wide areas.

Innovation: Compact, modular purifiers can be designed to fit on streetlights, benches, or vehicles, making them more adaptable and mobile. Solar-powered purifiers could be mounted on urban infrastructure to maximize coverage.

4. Durability and Weather Resistance

Challenge: Outdoor units must withstand various weather conditions, such as rain, heat, and pollution.

Innovation: Using corrosion-resistant materials like stainless steel or treated polymers extends durability. Encasing sensitive components (like batteries and electronics) in protective housings ensures longevity in harsh environments.

5. Smart Integration and Monitoring

Challenge: Real-time monitoring and adjusting of air quality across different areas can be complex and require a robust system.

Innovation: Adding IoT sensors allows the purifier to track pollution levels, adjusting operations based on need. These sensors can also collect data for urban planners, creating a more responsive urban air management system.

Developing solar outdoor air purifiers requires a blend of advanced energy storage, smart materials, efficient filtration methods, and data-driven responsiveness. Each of these solutions, if implemented effectively, could push forward the potential for cleaner urban air with renewable energy.

VII. CONCLUSION

The depicted battery-controlled setup for monitoring and supply of clean air is an essential need for smart cities and in industrial area. The purification of air in so important that it eradicates any air borne disease. The said method is user-friendly and has and efficiency of more than 95% in a polluted surface and air. This method is affordable and is capable to acquire the air instantly. The wastage of filters is normal in this case which is considered as a challenging task. The filters are to be cleaned every day and it can be changed every day if it

is affordable to buy. Cleaning the filters are more than enough. Further it can be modified by

using large containers and large filter system.

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