



# Design and Construction of a Room Air Purifier for Clean Domestic Ventilation

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## Abstract

*Aerial pollutants including dust, pollen, pet dander, volatile organic compounds (VOCs), and even harmful microbes can build up as a result of poor ventilation or insufficient air movement. In order to help maintain a healthy indoor environment, this study intends to build an air purifying system that may be installed in a room. The outcomes of our research showed how well the built-in air purifier improved indoor air quality. The microorganisms in the airflow were significantly decreased by the device. With an average CADR of 200 CFM, the Clean Air Delivery Rate (CADR) measurements showed a considerable decrease in particle concentration with time. It was discovered that the starting particle concentration affected the decrease in particle concentration. Depending on the particle size and the length of operation, the concentration was reduced by 80%, 90%, or more than what was present in the room or surrounding area. The results shown here demonstrate that the device's used air purifier successfully reduces the amounts of germs in the airflow.*

**Keywords:** Construction, Ventilation, Airflow, Bacteria, Indoor, Clean Air Delivery Rate (CADR), Measurements.

## INTRODUCTION

A major public health risk is air pollution, especially in cities with closely sealed buildings. Inadequate ventilation can lead to the build-up of several pollutants, such as dust, pollen, pet dander, volatile organic compounds (VOCs), and dangerous bacteria (Anderson and Thompson, 2022). By addressing these problems and improving indoor air quality, the suggested solution a room air purifier aims to create a healthier living environment. Our health and well-being are directly impacted by poor indoor air quality (Anderson and Thompson 2022).

According to the Environmental Protection Agency (EPA 2019), poor ventilation and a variety of contaminants that can cause allergies, respiratory disorders, and other health concerns have made indoor air quality a major concern. Indoor air pollution is seriously threatened by the build-up of airborne contaminants in residential areas. The purpose of this effort is to develop and build a room air purifier that can offer clean home ventilation in response to this issue. Although chemical disinfectants are widely used to eradicate dangerous bacteria, this strategy has a number of significant drawbacks. Certain circumstances, such as the presence of organic materials or microbial resistance, may cause chemical agents to be less efficient, which might

result in the partial or selective inactivation of infections (Abreu *et al.*, 2013). In order to achieve effective germ reduction, many chemical disinfection procedures need for extended contact times, sometimes several minutes (Abreu *et al.*, 2013). Concerns have also been raised about the discharge of hazardous or residual by-products, which can endanger human health and contribute to environmental contamination (EC, 2022). Additionally, the use of traditional chemical cleaning techniques to manage bio-aerosols is limited since they are mostly surface-based and may not be effective against airborne germs (Nguyen *et al.*, 2022). In order to increase efficiency and environmental safety, there has been a growing interest in the development of alternate disinfection technologies, such as physical and sophisticated oxidation techniques (Martínez-Huitle and Brillas, 2021).

In interior environments, such as hospitals, schools, and trains, the use of effective and affordable air purifiers offers a major benefit in reducing human exposure to virus-laden aerosols. But in order to avoid secondary contamination, most air purifiers require filter replacement or disinfection, which raises costs and energy consumption (Parker *et al.*, 1960). Brown's thorough review study from 2021 offers insightful information on these techniques. Though mainly for the removal of dust and soot, the use of electromagnetic fields to clean the air has long been a matter of concern.

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For decades, scientists have battled to resolve the inherent conflicts between filtration efficiency, low air resistance, and extended service life in the majority of fibre filtering systems.

This study produced a revolutionary, inexpensive air purifier that uses a mix of UV light and a direct high voltage electric field to eradicate microorganisms in the air in order to solve most of the problems related to air purification. To increase the effectiveness of eliminating microorganisms, the electric field is designed to be strong and multidirectional. This instrument's prototype was successfully built and proved to be highly effective against high bacterial concentrations. In 2020, companies like airlines, hotels, and retail establishments have depended more and more on ultraviolet light, which has long been a proven disinfectant in labs and hospitals. The epidemic has also resulted in a proliferation of low-cost, unregulated consumer-focused gadgets for use at home, such as portable wands that enable users to wave exposed UV light over objects and surfaces. Electromagnetic radiation that is invisible to the human eye and has a wavelength between 180 and 400 nanometres is known as ultraviolet light. In contrast to less intense UVA and UVB radiation, UV light, which ranges from 180 to 280 nanometres, is the most powerful part of the ultraviolet light spectrum and may burn skin in a matter of seconds. Lastly, the Earth's atmosphere completely absorbs natural UVC rays from the sun (WHO 2018).

The fields that deal with medical equipment require recognition that these gadgets are not toys and cannot instantly cure illnesses. For the gadget to fulfil its intended function, it must stay in place for a predetermined amount of time (Brown, 2021). According to (WHO 2018), several products already on the market seem to undervalue or completely ignore these possible dangers. The creation of an air filtration system that may be installed in a room to help maintain a healthy indoor atmosphere is the primary goal of this study.

### MATERIALS AND METHOD

#### Material Used in Construction

- i. Resistor
- ii. Adaptor
- iii. Switch
- iv. High efficiency particulate Air (HEPA) filter
- v. Light emitting diode (LED)
- vi. Acrylic plastic
- vii. Epoxy glue Gum

#### Resistor

Electrical resistance is implemented as a circuit element by the resistor, a passive electrical component having two terminals. Power distribution systems, motor controllers, and generator test loads can all require high-power resistors

that can waste a large amount of electrical power as heat. It is crucial to remember that the resistances of fixed resistors only slightly vary with respect to operation voltage, time, or temperature. On the other hand, variable resistors can be used as sensors for heat, light, humidity, force, or chemical activity, or they can be used to modify circuit components like a volume control or a lamp dimmer (Lee and Kim, 2022).

#### Adaptor

An adaptor is a tool used to change the characteristics of an electrical system or device that would not work with another system or device. Adaptors can merely change the physical structure of one connection to another, or they might change the power or signal characteristics.



Figure 1. Adaptor.

#### Acrylic Plastic

Known by a number of names, including PMMA (Polymethyl methacrylate), Plexiglass, Plexiglas, and others, acrylic plastic is an optically transparent thermoplastic substance with the chemical name "plexiglass" with remarkable strength, rigidity, and optical clarity. This material has many similarities to polycarbonate and is widely used as a glass alternative due to its great impact resistance (Lee and Kim, 2022). In a single local area network (LAN), a network switch is a small device that centralises communication between several connected devices.

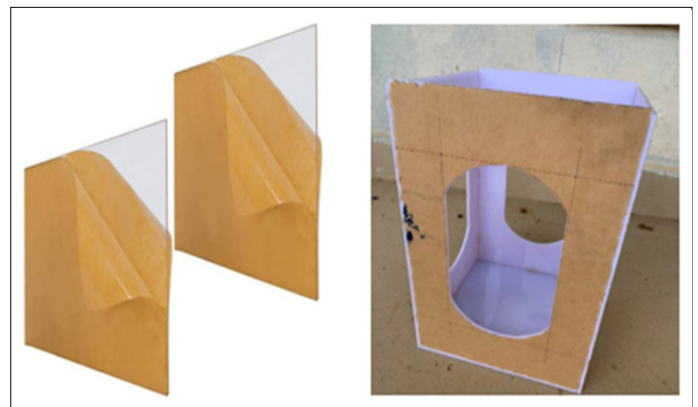
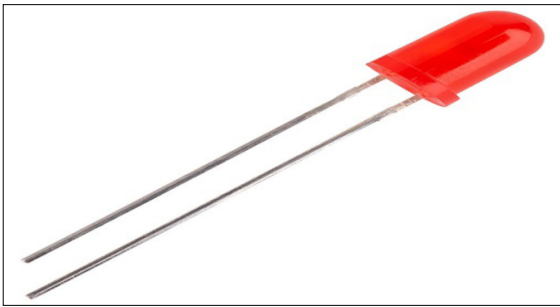


Figure 2. Acrylic plastic.

#### Light Emitting Diode (LED)

When electric current passes through a semiconductor device called a light-emitting diode (LED), it may emit light. Light is released as electrons and holes recombine as the current flows through the LED. LEDs allow electricity to flow

forward while preventing it from flowing backward (Lee and Kim, 2022).



**Figure 3.** Light Emitting Diode (LED).

### HEPA Filter

HEPA filters are a kind of filtering system that has the crucial purpose of eliminating airborne particles that might endanger human health. The pleated mechanical filter that makes up a HEPA filter makes it easier for it to efficiently remove pollutants from the air. With an astounding 99.97% success rate, HEPA filters can remove dust, pollen, mould spores, pet hair, and germs from the environment. HEPA filters' primary goal is to eliminate particles larger than 0.3 microns in order to contribute to the development of a healthier environment (Lee and Kim, 2022).



**Figure 4.** HEPA Filter.

### Switch

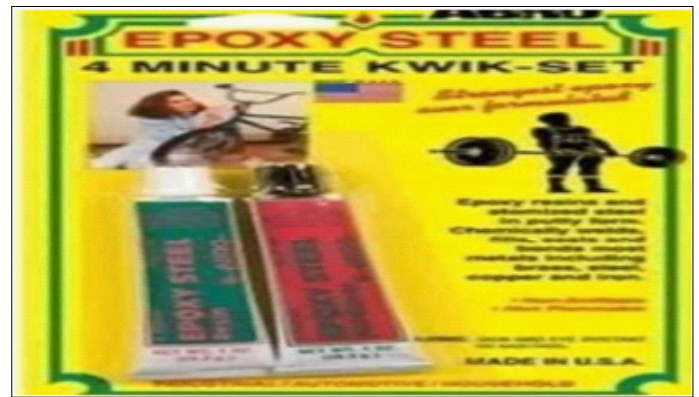
By dividing a connection-oriented network into segments and creating a dedicated link between the sender and the recipient, the Switch approach guarantees a predefined data rate.



**Figure 5.** Switch.

### Epoxy Glue (Gum)

A synthetic mixture of a resin or epoxy polymer and a hardener, epoxy adhesive is used to create a strong, flexible, and long-lasting thermosetting bond that can tolerate extreme stress and weather conditions. Furthermore, epoxy glue acts as a filler in its liquid stage, filling up spaces before it chemically cures without shrinking (Chen and Li, 2023).



**Figure 6.** Epoxy glue (Gum).

### Runda Fan Blower

In both home and commercial settings, the air blower machine is a simple yet effective electrical device that disperses dust particles from every nook and crevice. This tool is particularly helpful for clearing dirt from complex devices and electronics that are difficult to clean with a cloth. The air blower uses a constant stream of air pressure to do this. Additionally, this machine's durability and effectiveness significantly cut down on the time and effort required for dusting and cleaning tasks (Chen and Li, 2023).



**Figure 7.** Runda fan blower.

### Connection Wire

In an electrical circuit, connection wire acts as an electrical conductor that makes it easier for electricity to be sent from one particular spot to another.



**Figure 8.** Connection wire.

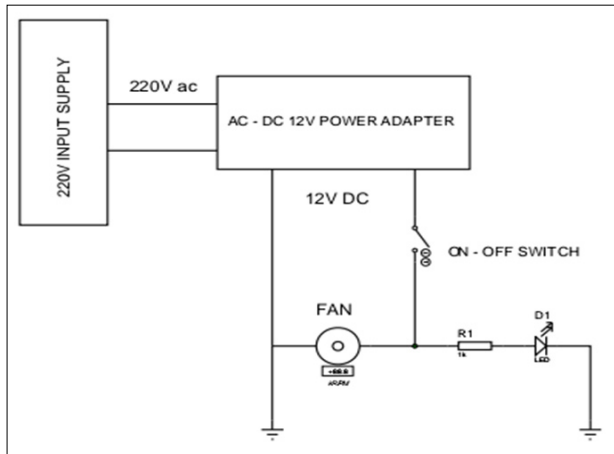
### Circuit Description

The adapter receives the 220 volt AC power supply and steps it down from 220 volts to 12 volts. The circuit can be powered by this reduced voltage. By essentially lowering the provided AC voltage to 12 volts DC, the adapter serves as the circuit's regulator and protector. The switch, which then decides whether the circuit is open or closed, receives the DC current. When the circuit is closed, power is delivered; when it is open, power is shut off. In order to prevent damage or burning, the R1 resistor acts as a current-limiting component by opposing the current delivered to the LED (Gomez, 2023).

The LED serves as a signal for the presence or absence of electricity in the circuit. Lastly, the fan, which is intended to attract tiny particles to the “HEPA” filter, only functions when the adaptor is used to supply it with 12 volts DC.

### Methods of Construction

**Method 01:** Involves accurately measuring and cutting the acrylic plastic into four equal pieces and one square piece.



**Figure 9.** Circuit Diagram.

**Method 02:** In this method, frames are made by cutting acrylic plastic and adhering it to the edges with epoxy glue.

**Method 03:** Using epoxy glue, the HEPA filter is positioned in the middle of each of the four faces and at the bottom of the frame.

**Method 04:** Requires connecting the resistor to the adapter plug and soldering it to the LED.

**Method 05:** In order to fully cover the surfaces and link it to the switch, the fan blower is attached to the top surface of the HEPA filter using epoxy glue (Gomez, 2023).

### Method of Measurement

#### Airflow Test

The airflow in the system will first be examined. Clear, steady airflow is a feature of a functional air purifier. There’s probably an issue if the purifier isn’t blowing out air, which can be readily checked by putting your palm in front of the device. Another indication that the purifier isn’t functioning is if anything couldn’t hear. On the other hand, if the purifier makes a lot of noise or appears to be working very hard to blast air, which is also an issue. We’ll keep an eye out for the perfect midway sweet spot for ventilation.

#### Filter Test

Examining the device’s internal filters is known as the filter test. A dirty or full filter indicates that the system is operating. This indicates that when air enters the apparatus, contaminants are captured by the filter before the air exits. However, it’s crucial to replace the filter as soon as it becomes blocked or unclean. Although it is a positive indication, a full filter makes it more difficult to force air through and prevents the purifier from operating effectively.

## RESULT AND DISCUSSION

### Result

The test outcomes showed how well the built-in air purifier improved indoor air quality. The gadget significantly decreased the amount of germs in the airflow, as anticipated. With an average CADR of 200 CFM, the Clean Air Delivery Rate (CADR) measurements showed a considerable decrease in particle concentration with time. This implies that a significant amount of clean air might be delivered by the purifier in a given amount of time. It was discovered that the starting particle concentration affected the decrease in particle concentration. The air purifier was more successful in settings with higher particle loads because higher beginning concentrations led to a larger decrease.

Depending on the particle size and the length of operation, the concentration was reduced by 80%, 90%, or more than what was present in the room or surrounding area. The best way to assess the impact of the equipment would be to use an air sampling device for active air sampling in a small area. But in the end, this experimental approach would not be able to fully determine the device’s ability to reduce bacterial numbers. The results shown here demonstrate that the device’s used air purifier successfully reduces the amounts of germs in the airflow.

### Discussion

A room air purifier’s construction entails the meticulous selection and installation of several parts to produce an efficient and successful air purification system. The fan is in charge of generating airflow and bringing air into the purifier. To guarantee effective circulation in the space, choosing a fan with the right power and airflow capacity is essential. To ensure a peaceful operation, the fan’s noise level should also be taken into account. Filters are essential for eliminating pollutants and airborne particles. Pre-filters, HEPA filters, UV filters, and carbon filters are a few examples of the many filter types that activate and fulfil particular functions during the purifying process. While HEPA filters eliminate tiny particles like pollen and pet dander, pre-filters collect bigger particles.

While UV filters sterilise the air by neutralising germs and viruses, activated carbon filters aid in the removal of odours and dangerous gases. The housing unit controls the airflow and gives the parts a framework. In order to ensure effective circulation throughout the space, it should be constructed to maximise air intake and outflow. Other crucial elements to take into account include the housing unit’s strength, portability, and simplicity of cleaning. The fan is powered by the motor, which also keeps the airflow constant. It should be energy-efficient to reduce power consumption while having enough power to run the fan efficiently. For the air purifier to last a long time, the motor’s longevity and durability are crucial factors.

Different modes of operation are activated via control

devices, such as switches and buttons that let users modify the airflow speed. To ensure a convenient user experience, these methods should be easy to use and intuitive. Safety factors should be properly attended to during the assembling process. In order to build a system that efficiently eliminates pollutants from the air, a room air purifier requires careful component selection and assembly. A well-designed and efficient air purifier may be built by taking into account the fan, filters, housing unit, motor, control mechanisms, and other components.

### 4.0 CONCLUSION

This study developed and built an inexpensive, simple device for air filtration in a small area. Purified air is released after the process extracts particulate particles and dirty air from the surrounding area. Our results demonstrate the device's remarkable effectiveness even in the presence of high air pollution levels. In order to stop the spread of airborne infections, the gadget is especially useful for disinfecting indoor air in enclosed spaces like homes, schools, and hospitals.

In conclusion, careful component selection and installation are necessary to build a room air purifier that efficiently eliminates airborne pollutants. A well-thought-out and useful air purifier may be built by taking into account the fan, HEPA filters, and housing control.

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