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Filter Less Air Purifier

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Abstract –

Filterless air purifiers are emerging as a revolutionary solution for improving indoor air quality by utilizing advanced technologies that eliminate the need for traditional filters. These devices employ methods such as electrostatic precipitation, ultraviolet (UV) light, and ionization to effectively capture and neutralize a wide range of airborne pollutants, including dust, allergens, smoke, and harmful microorganisms. By removing the reliance on disposable filters, filterless air purifiers not only reduce ongoing maintenance costs but also minimize environmental waste, making them a more sustainable choice for consumers concerned about both health and ecological impact.

In addition to their practical benefits, filterless air purifiers often incorporate smart technology that enhances user experience and efficiency. Features such as real-time air quality monitoring and automatic adjustments based on detected pollutants ensure optimal performance while conserving energy. With their sleek designs and quiet operation, these purifiers seamlessly integrate into various settings, from homes to offices, providing a convenient and effective means of maintaining a healthier indoor environment. As awareness of the importance of clean air continues to grow, filterless air purifiers are poised to become a popular choice for individuals seeking to enhance their well-being and quality of life.

Key Words –

1) Air Quality
2) Pollutant Removal
3) Electrostatic Precipitation
4) Ultraviolet (UV) Light
5) Ionization
6) Maintenance-Free
7) Sustainable
8) Cost-Effective
9) Smart Sensors
10) Real-Time Monitoring
11) Energy Efficient
12) Compact Design

1. INTRODUCTION –

Filterless air purifiers are an innovative advancement in the realm of indoor air quality management, designed to provide effective air purification without the need for traditional filters. As concerns about air pollution and its impact on health continue to rise, these devices offer a practical solution for individuals seeking cleaner air in their homes and workplaces. Utilizing cutting- edge technologies such as electrostatic precipitation, ultraviolet (UV) light, and ionization, filterless air purifiers efficiently capture and neutralize a wide array of airborne pollutants, including dust, allergens, smoke, and harmful microorganisms.

One of the standout features of filterless air purifiers is their low maintenance requirement. Unlike conventional air purifiers that necessitate regular filter replacements, filterless models eliminate this hassle, allowing users to enjoy continuous air purification without the added expense and waste associated with disposable filters. This not only makes filterless purifiers a more economical choice but also aligns with a growing emphasis on sustainability and environmental responsibility.

Moreover, many filterless air purifiers are equipped with smart technology that enhances their functionality and user experience. Features such as real-time air quality monitoring and automatic adjustments based on detected pollutants ensure optimal performance while conserving energy. With their sleek designs and quiet operation, these purifiers seamlessly integrate into various

settings, making them an attractive option for anyone looking to Improve their indoor air quality. As awareness of the importance of clean air continues to grow, filterless air purifiers are poised to become

a popular choice for maintaining a”healthy indoor environment.

2. METHODOLOGY

2.1 DESIGN

The design of filterless air purifiers is characterized by a compact and sleek form factor that seamlessly integrates into various indoor environments,
combining advanced purification technologies such as electrostatic precipitation, ultraviolet (UV) light, and ionization within a modular framework for
optimal effectiveness. These devices feature an efficient airflow system that maximizes air
circulation while minimizing noise, along with user- friendly controls and smart features like real-time air quality monitoring and mobile app integration for
convenient operation. Emphasizing energy efficiency and sustainability, many models utilize low-power consumption technologies and eco-friendly materials, while incorporating safety features such as automatic shut-off mechanisms and child locks. Overall, the design of filterless air purifiers not only enhances indoor air quality but also aligns with modern aesthetic preferences and environmental considerations.

Fig 1: Solidworks model on solidworks

MAIN COMPONENTS

Fig. 2: Electrostatic Case

1) Electrostatic Case

An electrostatic case utilizes high-voltage electrodes to ionize airborne particles, giving them a charge. These charged particles are then attracted to oppositely charged collection plates, effectively capturing pollutants like dust and allergens. The clean air is released back into the environment, improving indoor air quality. This system allows for easy maintenance, as the collection plates can be cleaned and reused.

2) Electrostatic Generator CKT

An electrostatic generator circuit consists of a high- voltage power supply, a charging mechanism (like a moving belt), and electrodes that collect the generated charge. The charge is stored in a capacitor for later use. A discharge terminal allows the release of the stored charge, often producing a spark. This setup is commonly used in devices like Van de Graaff generators.

3) SS Spike

A stainless steel (SS) spike in an air purifier is used as an ionization electrode. It generates negative ions by creating a high-voltage electric field, which helps to charge airborne particles. These charged particles are then attracted to collection plates, improving air quality. The SS material ensures durability and resistance to corrosion.

3. Working of filterless air purifier

Fig 3. Filterless Air Purifier

A filterless air purifier operates by utilizing ionization and electrostatic principles to effectively clean the air without the need for traditional filters. The process begins with the air intake system, which draws in contaminated air from the surrounding environment through vents or grilles. This air often contains various pollutants, including dust, allergens, smoke, and other particulate matter that can affect indoor air quality.

Once the air is drawn into the purifier, it enters the ionization chamber, where high-voltage electrodes generate negative ions. These ions attach themselves to airborne particles, imparting a negative charge to them. This ionization process increases the weight of the particles, making them more likely to settle out of the air or be attracted to collection surfaces within the purifier.

The charged particles are then attracted to oppositely charged collection plates or surfaces inside the unit. This electrostatic attraction helps to remove the contaminants from the air, effectively reducing the concentration of harmful particles. As the particles accumulate on the collection plates, the air that is circulated back into the room is significantly cleaner and healthier to breathe.

Finally, a fan or blower circulates the purified air back into the living space, ensuring continuous air exchange. The absence of traditional filters not only simplifies maintenance but also reduces ongoing costs associated with filter replacements. Overall, filterlessair purifiers provide an efficient and convenient solution for improving indoor air quality.

4. COMPONENTS LIST

Sr. No.	Component Name	Quantity
1	Acralic Body	1
2	Electrostatic generator Ckt	1
3	SS Spike Laser Cut	4
4	SS Dust Collecting Plate	1
5	Copper Rod	1
6	SS Connector	1
7	12 V Power Supply	1
8	On/Off Button	1
9	Power Connector	1
10	Programmable IC	1

5. CALCULATIONS

To calculate the required capacity of an air purifier without a fan, you need to determine the Clean Air Delivery Rate (CADR) and the room volume. The CADR, typically in cubic feet per minute (CFM), indicates how much air the purifier can clean per minute. The room volume is calculated by multiplying the length, width, and height of the room. A general rule of thumb is to aim for an air purifier that can clean the room's air at least twice per hour, or 3 times for more demanding situations.

Here's a more detailed breakdown:

1. Calculate Room Volume:
Measure the length, width, and height of the room in feet.
Multiply these measurements together: Room Volume = Length x Width x Height.

2. Determine CADR:
Refer to the product specifications of the air purifier to find its CADR rating, usually in CFM.
You may need to convert the CADR to cubic meters per hour (m3/h) if it's not given in CFM.

3. Calculate Required CADR:
Multiply the room volume by 2 (or 3 for higher air change rates). This gives you the minimum CADR needed to clean the air at the desired rate.

For example, a 10ft x 10ft x 8ft room (800 cubic feet) would require a minimum CADR of 1600 CFM (800 x 2).

4. Consider Air Changes per Hour (ACH):
ACH refers to how many times the air in a room is replaced with clean air per hour.
Most spaces should aim for 2-6 ACH.
For example, to achieve 2 ACH in a 1000 cubic foot room, you would need an air purifier with a CADR of at least 133 CFM (1000 / 8.33).

In essence, the goal is to select an air purifier with a CADR that's large enough to clean the entire volume of the room at a desired rate of air changes per hour (ACH), without relying on a built-in fan for circulation, according to the Air Health blog.

CONCLUSION

Reducing air pollution is crucial for safeguarding human health. Effective measures include transitioning to cleaner energy sources, improving emission controls, and promoting cleaner transportation. Air purifiers and advanced filtration systems can also help reduce indoor exposure to harmful pollutants

The future of ESP air filters lies in technological innovation, energy efficiency, hybrid systems, and integration with smart technologies. As air pollution becomes a more pressing issue globally, ESPs will play an increasingly significant role in improving both indoor and outdoor air quality across industries and urban areas.

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