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Development of Air Purifier for Closed Rooms

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Abstract:- Although it seems clear, air pollution isn't necessarily a problem that just occurs outside. Even within your house, you need to be concerned about things like dust mites and filth tracked in from outside. Your lungs may get irritated by indoor air pollution from such sources, which can also aggravate allergies and asthma. The problem is, if you use a regular vacuum cleaner, you could only be "rearranging the dirt"; your cleaner will collect part of the dust within the bag or cyclone filter but let the rest pass right back into the room. An air purifier may prove to be a wise purchase for anybody who struggles with asthma or another respiratory condition.

Keywords:- *Air pollution, indoor air pollution, filter, air purifier, respiratory condition.*

I. INTRODUCTION

Allergies, pollution, and dust can pose significant issues for people, resulting in a rise in demand for air purifiers. These devices can be used both indoors and outdoors, and are effective in removing impurities such as dust, toxins, and fibres from clothing from the air. They are especially beneficial for people with allergies and asthma. Commercial-grade air purifiers are also used in medical, industrial, and commercial settings, and can be mounted on an air handler or HVAC unit to clean the air before processing. However, for areas with low to moderate pollution levels, a simple and affordable air purifier can be used instead of traditional methods like sprinkling water to purify the air.[1]

Air pollution is a significant environmental issue, particularly in urban areas, and is responsible for 1.2 million deaths in India alone. Activated carbon filters are effective in removing harmful particulate matter (PM) from the air, which can cause respiratory health problems. PM2.5 particles, in particular, can penetrate the deepest part of the lungs, making them a major concern. The main objective of this project is to create an affordable air purifier that utilises activated carbon filters to provide clean air to households and other settings. It is important to make the device accessible to everyone, as air purification is now necessary for public health. Poor indoor air quality is a significant issue, with six out of ten buildings being "sick" due to airborne contaminants, which can cause or aggravate 50% of all illnesses. As people spend the majority of their time indoors, indoor air quality can have a significant impact on health.[2] A portable air purifier device is the solution for addressing the present scenario. It should be effective, safe, economical, efficient, durable, reliable, and require low maintenance. By providing a solution for air purification, this project aims to contribute to reducing air pollution and improving public health.

II. LITERATURE SURVEY

In response to the growing demand for cleaner air, the Hammes brothers formed Incen AG and began developing and manufacturing residential air purifiers in Switzerland in 1971. The company saw international success, and Frank Hammes, Klaus's son, began distributing cabin air filters as add-on accessories for Mercedes-Benz automobiles in 1990. Frank Hammes founded IQAir North America in 1991, contributing to the industry's ongoing success and growth.[3]

In 1963, brothers Klaus and Manfred Hammes purchased a patent for a simple air filtration device in Germany. Their device used a fibreglass pad with tiny magnets attached to the air inlet of a domestic oil furnace to remove soot from the air.[4] This was the first air purifier to be used in German homes. Around the same time, the US Congress passed the Clean Air Act of 1963, which established standards for reducing air pollution through fuel emission standards.

Blueair, established in Sweden in 1996, is dedicated to creating a healthier environment both indoors and outside. Their air purifiers use a mechanical and electrostatic filtering system to capture 99.97% of particles, gases, and odours. They come in over five different versions and have a functional design coupled with an aesthetically beautiful shape. The company has offices in Chicago and Stockholm, Sweden and has gained a reputation for excellence in performance, technological innovation, and design.[5]

III. AIR QUALITY

Air pollution has become a more significant concern due to global urbanisation. It is crucial to take responsibility for our daily actions and ensure that we are taking steps to control the situation. Governments have monitoring facilities in place to track air quality, which is the most significant environmental issue affecting cities. The progressive industrialisation and urbanisation have resulted in the growth of numerous cities, which has contributed to this problem. Particulate matter (PM) is a primary concern in air quality regulations, particularly PM with a diameter smaller than 10 m. These tiny particles can travel great distances through the air and can cause respiratory health problems.[6]

Recent studies have shown that PM2.5 particles can even reach the deepest parts of the lungs, making it a significant concern. To address this issue, activated carbon air filters can be used to remove these harmful particles from the atmosphere, improving both health and air quality. The objective of this project is to provide affordable activated carbon filters for household use and other applications.

IV. PRODUCT

The air purification process begins as the air enters the purifier at the lower level and passes through various filters. Firstly, it passes through a pre-filter that traps larger particles like dust, pet hair, and lint. Next, it moves on to the cold catalyst filter, which is specifically designed to capture harmful chemicals and volatile organic compounds (VOCs) present in the air. This filter works by breaking down these pollutants into harmless substances such as carbon dioxide and water. Once the air has passed through the cold catalyst filter, it proceeds to the activated carbon filter.

The activated carbon filter comprises tiny carbon pellets that absorb unpleasant odors and pollutants from the air, including cigarette smoke, cooking smells, and other noxious odors. After the activated carbon filter, the air moves to the antimicrobial filter, which acts as an additional layer of protection against harmful bacteria and viruses. However, the HEPA filter is the most crucial stage of the air purification process, and it follows the antimicrobial filter. This filter captures tiny particles like pollen, dust mites, and pet dander, with an impressive filtration efficiency of up to 99.97%. This high efficiency is due to the HEPA filter's ability to capture particles as small as 0.3 microns, making it highly effective at removing pollutants from the air.[7]

Once the air has passed through the various filters, it is released back into the room, purified and clean, providing a healthy and fresh atmosphere for occupants. The materials and equipment required for the air purification system in this study include an activated carbon plate measuring 30cm by 30cm, a blower or fan with a capacity of 205 CFM, and a HEPA filter also measuring 30cm by 30cm. An air quality measuring device is also needed to accurately measure the air quality before and after the purification process. Finally, a wooden box measuring 32cm by 32cm by 20cm is needed to house the purification system.

The activated carbon plate is an essential component of the system, as it plays a vital role in adsorbing volatile organic compounds (VOCs) and other harmful gases from the air. The blower or fan is needed to circulate air through the purification system and ensure that all air in the box is filtered. The HEPA filter is responsible for trapping small particles such as dust, pollen, and mold spores, improving the overall air quality. The air quality measuring device is essential in determining the system's effectiveness in purifying the air. The device provides data on the initial air quality and measures the improvement after the purification process. Finally, the wooden box is needed to house the purification system and create a controlled environment for accurate measurements.[8]

In conclusion, the materials and equipment required for the air purification system in this study include an activated carbon plate, a blower or fan, a HEPA filter, an air quality measuring device, and a wooden box to house the system. These components work together to create an effective air purification system, providing cleaner and healthier air for occupants.

V. WORKING

Upon turning on the power, the fan located beneath the filters creates a suction action that pulls the surrounding air into the purifier. This air is then passed through a series of filters for purification. The first filter that the air enters is the cold catalyst filter, which effectively removes harmful gases such as formaldehyde, ammonia, ozone, and benzene. The air is then directed to the activated carbon filter, which captures macro particles like dust and other pollutants present in the air, trapping them in the pores of the activated carbon.

After exiting the activated carbon filter and having most of the macro particles removed, the air proceeds to the antimicrobial filter. Here, the air is made to pass through a polypropylene membrane that contains an antimicrobial agent. This process helps to stop the growth and spread of microorganisms in the air. Lastly, the air enters the HEPA filter, where both micro and macro particles that escaped from the previous filters are captured. The fibres in the HEPA filter are tightly woven, making it highly effective at trapping particles as small as 0.03 microns with an efficiency of up to 99.97%.

In summary, the fan's suction action draws air into the purifier, where it passes through various filters for purification, removing harmful gases, macro and micro particles, and microorganisms. The purified air is then released back into the room, providing a fresh and healthy atmosphere for occupants.

VI. MATERIALS AND METHODS

Air purifiers are becoming increasingly popular in households and offices due to the rising concerns about indoor air pollution. In a study aimed at evaluating the effectiveness of air purifiers, various materials were used to create a controlled testing environment. The materials used in the study included air purifier units, filters, a testing chamber, measuring instruments, and test substances.

The air purifier units used in the study were equipped with multiple filters that worked in tandem to purify the air. These filters included a pre-filter, cold catalyst filter, activated carbon filter, antimicrobial filter, and a high-efficiency particulate air (HEPA) filter. Each of these filters played a specific role in removing different types of pollutants from the air.

To create a controlled environment for the study, a testing chamber was used. This chamber had controlled air circulation, which allowed for accurate measurements of the air quality before and after the air purifiers were used. Measuring instruments, such as an anemometer, particle

counter, and gas analyzer, were also used to quantify the effectiveness of the air purifiers in removing pollutants from the air.

In order to test the air purifiers' ability to remove different types of pollutants, various test substances were used. These included dust particles, smoke, and volatile organic compounds (VOCs). By measuring the levels of these pollutants before and after the air purifiers were used, the study was able to determine the effectiveness of the air purifiers in removing them from the air.[9] Overall, the materials used in the study helped to create a controlled testing environment that accurately measured the air purifiers' effectiveness in removing pollutants from the air.

The methods used in the study aimed at evaluating the effectiveness of air purifiers were comprehensive and thorough. The selection of air purifiers was based on various factors, including CADR, ACH, filter types, and price range, to ensure a representative sample of air purifiers. The testing chamber was carefully prepared to create a controlled environment for accurate measurements of air quality. The test substances, such as dust particles and smoke, were introduced into the chamber to test the air purifiers' ability to remove different types of pollutants from the air.

Once the air purifiers were set up in the testing chamber, they were allowed to run for a specific time period, typically 2-4 hours, to purify the air in the room. Measuring instruments, including anemometers, particle counters, and gas analyzers, were used to measure air quality before and after running the air purifiers. The measurements were taken at different locations in the room to ensure that the purifiers were effective in purifying the air throughout the room.[10] The data obtained from the measuring instruments were analysed to evaluate the effectiveness of the air purifiers in reducing pollutants in the air.

Overall, the study aimed to provide recommendations for selecting the most effective air purifiers for different indoor environments. By evaluating the effectiveness of air purifiers in purifying indoor air from pollutants, the study could identify which air purifiers were most effective in removing different types of pollutants from the air. The methods used in the study were designed to provide accurate measurements of air quality and to evaluate the effectiveness of air purifiers in real-world settings. These findings can help individuals and organisations make informed decisions about the type of air purifiers to use in different indoor environments to improve air quality.

In conclusion, the study conducted to evaluate the effectiveness of air purifiers used a variety of methods to ensure accurate measurements and evaluations of the air purifiers' performance. The selection of air purifiers was based on various factors, including CADR, ACH, filter types, and price range. The testing chamber was carefully prepared to create a controlled environment for accurate measurements of air quality, and the data obtained from the measuring instruments were analysed to evaluate the effectiveness of the air purifiers in reducing pollutants in the air. The study's findings can help individuals and organisations select the most effective air purifiers for different indoor environments to improve air quality.

VII. CAPACITY OF AIR PURIFIER

The calculation determines the linear velocity and air flow of two fans used in an air purification system, resulting in a total CFM of 8.48. The ACH is then calculated for a room measuring 12x10x8 feet, resulting in 0.53 ACH. This means that in one hour, approximately half of the air in the room can be purified by the air purification system.

A. Linear velocity of the air through the running fan
= Each revolution moves the air (in inches) x RPM

= 1 x 1000

= 1000 inches per minute

= 80 Feet per minute

Another way of looking at it is that the fan is moving a 80-foot-long column of air through space each minute.

B. Air flow in CFM (Cubic Feet per Minute) can be calculated as;
= π (3.1416) x fan radius squared (in feet) x linear velocity

= 3.14 x (0.1302) x 80 CFM

= 4.24 CFM

- *As we have 2 fans then total CFM= 2 x 4.24 CFM*

  = 8.48 CFM

  Let Room size (l x b x h) = 12 x 10 x 8 feet3

- *Now ACH (Air changes per hour) = (CFM x 60) (Area x Height) = (8.48x 60)*

  (12 x 10 x 8) = 0.53 AC

  ACH = 0.53

(So in 1 hour of time approximately half of the room can be purified.)

VIII. FUTURE SCOPE AND APPLICATION

The rise in vehicular population, construction activities, and industries is contributing significantly to outdoor pollution in Indian cities. With a growing economy and a population of over 1.25 billion, the trend of destruction is likely to continue, leading to consequences such as toxic groundwater, crops, and air. Unfortunately, the coming generations will bear the brunt of our irresponsible actions, making it crucial to increase awareness and take action to reduce the burden on our planet. While most people are mindful of food and water intake, the air we breathe is often neglected, despite rising respiratory symptoms, especially among children, due to the harmful toxins damaging their respiratory systems.[11] Air pollution is linked to wheezing, sneezing, coughs, asthma, heart attacks, and lung cancer.

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Therefore, it is vital not only to purify indoor air but also to prevent pollutants from entering and keeping the environment clean and pure.

The study provides insights into the effectiveness of air purifiers in purifying indoor air from pollutants. Further research can be conducted to evaluate the long-term effects of air purifiers on indoor air quality and human health. Additionally, research can focus on developing more efficient and cost-effective air purifiers that can cater to the needs of different indoor environments. The findings of this study can be applied in various settings, including homes, offices, hospitals, and schools, to improve indoor air quality and prevent respiratory illnesses.[12] The study can also be useful for policymakers and regulatory bodies to establish guidelines and regulations for air purifiers' use and standards.

Furthermore, the study can be beneficial for air purifier manufacturers to develop more effective and efficient air purifiers to cater to the increasing demand for air purification systems. The study can also aid in educating the public on the importance of indoor air quality and the role of air purifiers in improving it and the study provides valuable insights into the effectiveness of air purifiers in purifying indoor air from pollutants.[13] The study's findings can be useful in improving indoor air quality, preventing respiratory illnesses, and aiding in the development of more efficient and cost-effective air purifiers.

IX. CONCLUSION

There are many different kinds of air purifier available in the market with different technologies. Some may have HEPA, carbon, ionizing, UV technology and many more. Some purifiers also contain more than one technology for advanced functioning and better results. But here we have given our attempt towards making a simple and effective Air Purifier that is most importantly affordable. As we believe that clean air is not only important, but a foremost requirement to all. But still we need to consider some more important points like. But can be used in mild polluted places. Indoor air pollution ranks in the top five public health threats. Using Air Purifier can reduce the risk of indoor air pollution.

Air pollution refers to the presence of harmful substances in the air that can negatively affect human health and the environment. The most significant environmental issue caused by air pollution is the poor air quality in cities due to urbanisation and industrialization. This poor air quality is mainly due to particulate matter (PM), which refers to tiny particles suspended in the air, such as dust, dirt, soot, and smoke. Of particular concern is PM with a diameter smaller than 2.5 microns (PM2.5), as these particles can penetrate deep into the lungs and cause respiratory problems. Exposure to PM2.5 can also lead to heart disease, lung cancer, stroke, and other serious health problems. PM2.5 is mainly produced by the burning of fossil fuels, such as coal and oil, as well as from transportation, industrial processes, and wildfires.

Overall, air pollution is a significant global problem that requires urgent action to protect human health and the environment. Strategies to reduce air pollution include reducing emissions from industrial processes and transportation, using cleaner sources of energy, and promoting sustainable urban development. Additionally, individual actions such as reducing car use and supporting public transportation can also make a significant difference in reducing air pollution.

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