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REDUCING CARBON EMISSION AND REMOVING OTHER DUST PARTICLE BY USING COMBINE HEPA AND ACTIVATED CARBON AIR FILTER

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Abstract: *Air filtration is a topic affecting everyone's lives, whether it is for occupational safety requirements, environmental or home health concerns. Control of airborne particulates in indoor environments is critical to develop quality products, protect employees from contact with hazardous materials, or prevent health problems from prolonged exposure to allergens. How airborne particulates are controlled varies from industry to industry and from an occupational setting to a home environment. To better understand why HEPA filters are used in the biological safety cabinet industry, it is necessary to explore particle sizes, types of filters available for home and occupational use, efficiency and penetration, filter standards and performance testing. If someone has an area in the home that is prone to dust particles, then pleated filter or home air filter will be the best one to rely on, as it is intended to handle more dust particles. Our experiment deals with removal of dust, pollen, mold spores, dust mites, and other allergens, removes most bacteria in exhaust gas, captures chemical fumes, gases, cigarette smoke, and odor, removes ultra-fine particles as small as 0.01 microns, remove of the microorganisms and all those viruses that creates allergic reactions.*

Key Words: Air filtration, Occupational safety, Airborne, Hazardous materials, HEPA, Allergens.

1. INTRODUCTION

A particulate air filter is a device composed of fibrous materials which removes solid particulates such as duct, pollen, mould and bacteria from the air or duct intake air flow. Filters containing an absorbent or catalyst such as charcoal (ex. carbon) may also remove odors & gaseous pollutants such as voltaic organic compounds or ozone. Air filter are used in applications where air quality is important notably in building ventilation system, industrial purposes, HVAC system and in engines. High efficiency particulate absolute (HEPA) originally called "High-Efficiency Particulate Absorber" but also sometimes called "High-Efficiency Particulate Arresting" or "High-Efficiency Particulate Arrestance", is a type of air filter. Filters meeting the HEPA standard have many applications, including use in medical facilities, automobiles, aircraft and homes. HEPA filter are composed of mat of randomly arranged fibers. The fibers are typically composed of fiberglass and possess diameter between 0.5 and 2.0 µm. The air space between HEPA filter fibers is typically much greater than 0.3 µm. One must have the ability to figure out which one among these is best for the sort of atmosphere that one may be confronting in their office or home. Setting them in one's ventilation system obliges a specific measure of knowledge and care. A particulate air filter is a device composed of fibrous materials which removes solid particulates such as dust, pollen, mould and bacteria from the air. Filters containing an absorbent

or catalyst such as charcoal (carbon) may also remove odors and gaseous pollutants such as volatile organic compounds or ozone.[1] Air filters are used in applications where air quality is important, notably in building ventilation systems and in engines. Some buildings, as well as aircraft and other human-made environments (e.g., satellites and space shuttles) use foam, pleated paper, or spun fiberglass filter elements. Another method, air ionizers, use fibers or elements with a static electric charge, which attract dust particles. The air intakes of internal combustion engines and air compressors tend to use either paper, foam, or cotton filters. Oil bath filters have fallen out of favor. The technology of air intake filters of gas turbines has improved significantly in recent years, due to improvements in the aerodynamics and fluid dynamics of the air-compressor part of the gas turbines.

2. LITERATURE REVIEW

The first concept of an air-purifier-type of product began as a protective air respirator that was worn over a person's mouth and nose. Its purpose was to filter air breathed through the unit, thereby protecting the wearer from inhaling any gases, fumes, vapors or harmful dusts particles. This concept was developed as far back as the 16th century. Leonardo da Vinci had an idea that water-dipped, fine woven cloth materials could protect sailors from breathing in any toxic powders used as weapons. In 1799, Alexander von Humboldt came up with a primitive sort of respirator that he used while he was a mining engineer. In fact, the very first air-purifying respirator developed by Lewis P. As time progressed, development of more effective types of air filtering devices became more prominent. During the late 1940s, the U.S. Army Chemical Corps and the U.S. Atomic Energy Commission developed the first HEPA filters to aid in the protection against radioactive chemical warfare agents [2]. These "collective protector filters," as they were initially called were later renamed "HEPA filters," which was an acronym for "High-Efficiency Particulate Air" filter units. These HEPA filters were designed with rigid frames and had a 99.97% "minimum particle removal efficiency" rate, while maintaining a maximum resistance of "one inche water gauge" when operated at a specific rate of airflow capacity. HEPA filters originally contained Bolivian or African asbestos components, which were imported into the United States. Due to the concern of the future availability of these asbestos papers, the U.S. government contacted Arthur D. Little; Inc. to develop a domestically available filter paper with equal or better filtration performance .They developed the first noncombustible "absolute filter" which was completely fire resistant. In 1963, Klaus Hammes, a German mechanical engineer, along with his brother, Manfred, created a "simple filter system" for German residential users. In 1994, Frank worked intensely with a team of engineers from Switzerland and Germany, taking four years to research and build the first, highly effective consumer compact air purifiers in the world. [3]

3. METHODOLOGY

Mechanical air filters remove particles from the air stream because particles come into contact with the surface of fibers in the filter media and adhere to the fibers. The mechanisms by which the particles come into contact with the fibers in the filter media are

straining, Interception, inertial separation and Electrostatic attraction is influenced by particle size. Electrostatic filtration is obtained by charging the media as a part of the manufacturing process. In this project work our main objectives are subdivided into seven major groups. Firstly, to remove dust, pollen, mold spores, dust mites and other allergens. Secondly, to removes most bacteria. Thirdly, to capture chemical fumes, gases, cigarette smoke, and odor. Then, to removes ultra-fine particles as small as 0.01 microns. Then, to prevent illness and disease. Then, to remove of the microorganisms and all those viruses that creates allergic reactions. Lastly, to remove all diseases and bad odors caused by bacteria, fungi and molds.

3.1 PROCESS OF AIR FILTRATION

In this type of air filter activated carbon used in the first layer of the pipe which absorbs mainly organic chemicals and paper filter is used in the medium layer of the pipe which absorbs a huge number of pollutant particles of air as shown in figure-3.2. The pollutant particles are captured using several different principles. For the most part particles come into contact with the filter, and are then trapped based on the principle of adhesion while clean air is free to circulate. Many holes are created in the all layer of pipe by drill machine so that air is passes through the pipe. One side of the pipe is closed and one side is open. The open side contain blower. When blower is pulled the air from the inner pipe air is entered the pipe by the hole from the surrounding. Smoke sensor indicates presence of pollutant air and display shows the percentage of pollutant air. From the leaving side of air the percentage of reducing particles are calculated. The importance of this phase when designing a product is to not only consider the product design specifications, but also to consider the activities beyond the design stage. Downstream activities typically are manufacturing, sales and transport. This stage is about drawing up a number of viable concept designs which satisfy the product design specification. Therefore, this is a two-stage process of concept generation and concept evaluation. At the beginning, the product concept could be abstract, complete or detailed. During the concept generation process, the focus should be on two main parts. Other cases include contaminants being trapped after achieving partial contact with the glass fibers, or being pressed up against the filter because of the strong air flow inside the purifier. Furthermore, airborne particles are attracted by other particles which are already trapped by the HEPA filter. Thanks to these various ways of stopping contaminant particles before they are able to pass through, HEPA filters can collect 99.9% of airborne impurities as long as they’re larger than 0.3 microns in diameter. Since most contaminants fall into that category, just imagine how much of an impact these filters have on the quality of air you breathe. Stuff like dust, allergens, pollen, dust mites, pet dander, mildew and mildew spores are eliminated with the use of a HEPA filter(especially useful for people who suffer with asthma or hay fever).

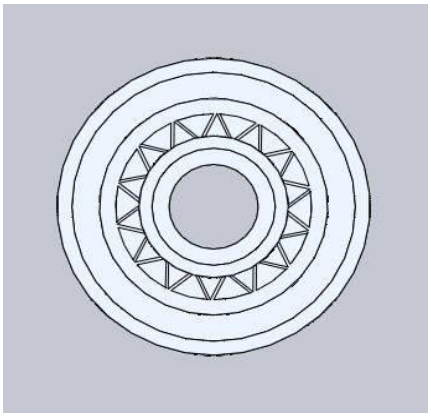


Fig 1: Prototype Air Fliter (Top View)

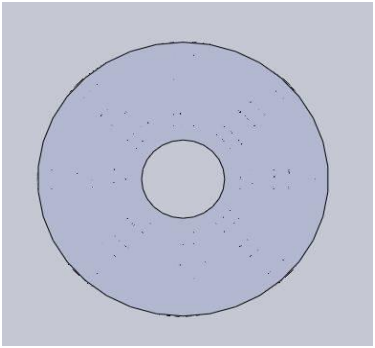


Fig 2: Prototype Air Fliter (Bottom View)

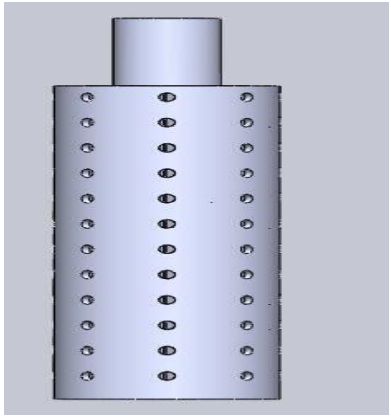


Fig 3: Prototype Air Fliter (Side View)

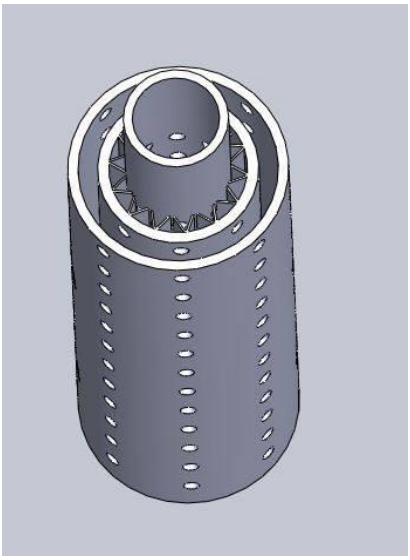
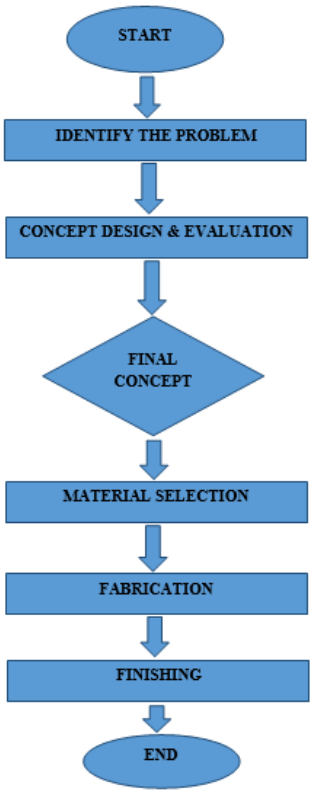


Fig 4: Prototype Air Fliter (Orthogonal View)

3.2 PROJECT FLOW CHART:



3.3 THE PROS AND CONS:

In pros, the function of the purifier is to remove air pollutants. An air purifier with a High Efficiency Particulate Absorption (HEPA) filter is able to capture at least 99.97% of air contaminants, down to 0.3 microns in size. Some of these small particles may have very large adverse effects. Most HEPA air filters are able to filter dust, smoke, asbestos, pollen, pet dander and many other common air pollutants. Additionally, air purifiers designed to remove specific pollutants may also be used — for example, air purifiers specifically for tobacco smoke removal. Overall, there are many different types and qualities of air purifiers. Anyone can measure the clean air delivery rate of any air purifier through the Room Air Cleaner Certification Program. This program sets the standard for air purifiers. And in cons, Ionic air purifiers may pose a danger to your health because they work through a chemical reaction that generates ozone (O_3), a strong oxidant. Although ozone is imperative to life on planet earth, its place belongs high in the atmosphere, and not on the ground or in our lungs. The FDA warns against the use of ionic air purifiers. Ozone's odor is sharp and chlorine-like, and can be detected by human olfaction at a concentration as low as 10 parts-per-billion (ppb).

3.4 REQUIRED INSTRUEMENTS:

for completing our project work we needed eight main and important mechanical and electrical accessories. They are: Paper Filter, Charcoal, Drill Machine, PVC pipe, Smoke Sensor, Microcontroller, Display and Blower.

3.5 PROTOTYPE FILTER CONSTRUCTION:

This type of air filter contains two type of filter. One is activated carbon filter and the other is paper filter. For that purpose there should have two stage of filtration in this filter. By adjusting three PVC pipe with different diameter this air filter is constructed. By drilling machine many hole should be created so that air passes through the filter. First layer contains activated carbon and the second layer contains paper filter which acts like HEPA filter. A smoke sensor and display should be connected for calculated efficiency of this filter. Smoke detectors are housed in plastic enclosures, typically shaped like a disk about 150 millimeters (6 in) in diameter and 25 millimeters (1 in) thick, but shape and sizes vary. Smoke can be detected either optically (photoelectric) or by physical process (ionization), detectors may use either, or both, methods. Sensitive alarms can be used to detect, and thus deter, smoking in areas where it is banned. A microcontroller (or MCU for microcontroller unit) is a small computer on a single integrated circuit. The detector is designed with a large opening in the bottom, shown upper right in our top photo that leads to the detection chamber up above. The photocell is an electronic light detector that generates electricity for as long as light falls on it. Normally, when there is no smoke about, the light beam shoots constantly between the LED and the detector.

Fig 5: Real view of our prototype Air Filter

4. RESULTS & DISCUSSION

HEPA filters are an example of mechanical filtration. The advantage to this filtration method is there is no reduction in its efficiency at removing the particulates from the air over time. In fact, a HEPA filter will become more efficient as it collects more particulates, because it is so fine. The only reason you need to eventually change it is because it will start to effect the airflow through the air purifier, which will result in a loss of air cleaning capacity and also may damage the motor because of the heat that may buildup. The disadvantage to this kind of filtration is that these air purifiers tend to be noisy, especially on the higher speeds. Activated carbon filters will be best at removing the VOCs and SVOCs, which are of a higher molecular weight. However, carbon filters will not be very effective in humid conditions where the air contains a large amount of water molecules. No sensor material is sensitive to a single gas only. I did some more research and found in principle two sensor of immediate interest to me: The MQ135 for "air quality" and the MQ811 for CO_2. The MQ811 is much more expensive (30$ compared to 3$). The datasheet claims that the MQ135 is sensitive for CO2, Alcohol, Benzene, NOx, NH_3 and the Fig 6 shows the change in resistance depending on the concentration of these gases in the ambient air in ppm (of the total gas volume). It turns out the the general sensitivity is the roughly same for all the gases. CO_2 is the 4th most abundant trace gas in the earth's atmosphere with about 400ppm concentration (N_2, O_2, and Ar are on place 1-3). All of the other gases the sensor detects are much less common than CO_2 and luckily so, as they are harmful. This means, in a normal atmosphere the sensor mostly detects CO_2 and with the right calibration we can use it as a cheap replacement for the MQ811 (which by the way is also sensitive to other gases).

Fig 6: Output value of prototype Air Filter

By finding the air quality in ppm from two sensor (one is input and other is output) can be calculated its efficiency.

Here, Air quality before filter, Q_1= 12.68 ppm

And Air quality after filter, Q_2= 0.5 ppm

Now filter efficiency, $\eta = (1-Q_2/Q_1)\times 100\%$

$= (1- 0.5/ 12.68)\times 100\%$

= 96.058%

Now it can be said that by adjusting two filter will show a greater filter efficiency.

5. CONCLUSION

Concluding from the literature studied for this paper, High Efficient Particulate Air (HEPA)-Filter air cleaning devices scientifically proven the highest efficiency in removing particles. Ion generators seen and the based ASHREA testing method of -HEPA-devices will significantly reduce indoor air pollution and the ensuing haze risk if operated properly. However, those devices are cost-intensive not only in purchase but also in maintenance (power, filter change). As haze from forest fires represents only a temporary phenomenon with occurrence cycles of 2-4 years, and duration of less than 3 month, the expenses might exceed the benefits. For a temporary reduction of indoor haze pollution as an emergency response, upgrading your air-conditioner with special filters, however, represent the most simple and cost effective alternative. It should be noted that air cleaning devices (portable air cleaners or upgrading air-conditioning) are only effective if applied in sound relation of the device' removal rate and the room used. Reducing indoor haze pollution in all rooms of your house/apartment will need high investments. The most practicable will be to reduce indoor pollution in one or two rooms only, most suitable parents and children's sleeping rooms and two spend also most of the daytime in this room during high outdoor pollution levels.

6. REFERENCES

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