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ADVANCEMENT IN AIR PURIFIER

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Abstract -Rapid industrialization and exponential growth of population directly or indirectly resulted in air pollution in different ways. Just like the need of fresh and pure water for healthy human habitat, fresh air is also another very important need of life. At present in most of the cities across the world, the air pollution is increasing and is at alarming state. The objective of this project is to filter and purify the surrounding air at an economical way for healthy life of population. Even though many varieties of air filters are available in the market, they are both built with limited air filters and costlier too. The present work uses number of types of air filters to remove macro and micro particulate matter, odor, toxic gases etc. from the incoming air to the filter. The purification of air in a room is continuously done and made to circulate. The purified air can also be connected to air conditioner at its inlet to reduce load on it. The device makes use of pre filter and cold catalyst, carbon filter, anti-bacterial filter, Ultraviolet light in sequence for filtering the incoming air. It is experimentally proved that the designed filter has higher air filtering efficiency and cost of the device may be made affordable if manufactured in large volume.

Key Words: Air pollution, Air purification, Cold catalyst, HEPA Filter, Air Quality

1. INTRODUCTION

The common problem during the summer season is the air pollution by smoke, dust and allergies. Higher air quality index (AQI) indicates increased air pollution which leads to higher health risks. Due to increase in air pollution, people frequently use air purifier as a basic need of life for domestic use or in offices in metropolitan cities as precautionary measure of issues due to polluted air. Lower AQI below 50 is said to be safe whereas higher AQI above 300 level pose severe impacts on health due to polluted air. The five major air contaminants are ground level ozone, particulate matter PM2.5 to PM10, Carbon monoxide, Sulphur Dioxide, Nitrogen Dioxide.

The contaminants like dust particles, fine fibers present in the air are filtered and removed by air purifiers. Commercially available air purifiers may be small units or larger units. These can be fixed to an air handler unit (AHU) or to a heating and air-conditioning (HVAC) unit. Air purifiers are also used to remove impurities such as carbon dioxide gas from air before processing. The contaminants from air are removed using different filters in different stages.

Air purifier with HEPA filter, Activated Carbon Filter (ACF) enhances AQI of filtered air. Particulates of relatively larger and smaller size are filtered at various stages. Solar energy operated air filters are also developed Baltrėnas, P. Zagorskis, etal analyzed proposed negative ionic air purifiers. They did the test in natural decay & air mixing mechanism in a sealed chamber. It is studied that, at a minimum height of 60 cm, filtering efficiency is maximum. Subramanian Sundar Rajan[2] evaluated in his research papers that, HEPA and activated carbon filters are effective to remove dirt molecules. HEPA filters have an efficiency of up to 99.97% to filter micro particles and disinfect microorganisms present in air [3]. Sulphur and its constituents are filtered by activated carbon which are in clusters of sulfates and sulfites, having bonded to Na and Fe. The adsorption efficiency depends on time. Research has shown that carbon filter can absorb Slphur,Sodium &Iron Sulphites. [4]. S. B. Divate, S. R.Kadam et al [5] shown that activated carbon has higher adsorbing efficiency than other filters. Yoshiko Yoda, Kenji Tamura et al [6] have said that it is not clear still whether air purifiers increase respiratory health. Their research included thirty two healthy individuals and two air purifiers and tested for 12 weeks. Study conducted in Shanghai, showed a significant 57% drop in PM2.5. When the room was kept sealed for two days.. A study on COPD patients exhibited that exhale of hydrogen sulfide & nitric oxide increased significantly with the increase in air pollutants. FeH_2S is efficient in detection of the adversative respiratory issues due to air pollution.

2. MATERIALS & METHODOLOGY:

Advanced air purifiers have various stages of air filtration; cold Catalyst filter Honeycomb activated carbon filter, Antibacterial filter, HEPA Filter, Ultraviolet sterilize light filter. Pre-Filter filter removes heavy particulates, human hair etc. The cold catalyst filter removes benzene ammonia, formaldehyde hydrogen sulphide and harmful gases. Through adsorption process Activated Carbon Filter (ACF) removes contaminants from air. It also removes odors from air. Addition of activated carbon, zeolite, potassium permanganate to air to the filtering system absorb odour, smoke, chemical vapors and other gases present in contaminated air. Filtering system with

chemical adsorption materials or activated carbon neutralizes odour and harmful chemicals and gases in its pores

2.1 Pre-Filter

The macro sized particulates which are usually more in polluted air, are trapped initially using a pre-filter. This is also necessary to safe guard the delicate HEPA in the next stage of filtering. Otherwise the macro sized particulates will block the filters arranged in the next levels of filtering.

2.2 HEPA Filter

A fine fiber like material used in making HEPA filter & is folded back& forth to form a maze of randomly arranged fibers. This offers a very large surface for air to get forced in by the purifier fan. Suitable design is made for smooth air flow through the system during air filtration. Allowing relatively large air flow filters the pollutants effectively. Usually HEPA filters last long for about three to four years.

2.3 Ultraviolet Light

A variety of bacteria's will be sterilized using ultraviolet light. UV light works independently to neutralize microorganisms. Use of germicidal lamp purifies the air.

2.4 Suction Fan

To pull the air through the filter, a small electric fan as is used on one side of filter system where as the filtered air will exit on the other side of fan. Fan is an important component in filter system.

2.5 Cold catalyst filter

The cold catalyst filter is effective at removing formaldehyde, benzene ammonia, hydrogen sulphide, and harmful gases.

2.6 Carbon Filter

Absorbs and collects dust, pet hair, allergens, smoke fumes and harmful gases. Activated Carbon Filter uses activated carbon to remove contaminants from air through adsorption. In addition to pollutants this filter is also effective in removing odours from the air.

2.7 Anti-microbial Filter

Anti-microbial Filter is just 5 microns thick helps to trap harmful, disease causing microbes and keep them out of the air that you breathe indoors. Antimicrobial agent effectively kills bacteria in air

3 FILTERING PROCESS

When the fan operates, a suction action is formed across the filters and air starts moving towards lower pressure region. The cold catalyst filters initially filters the harmful gases are. The macro particulates get arrested in the pores of activated carbon filter. Afterwards, the air passes through the antimicrobial filter. The air is forced to pass through an antimicrobial agent polypropylene membrane. The microorganisms get trapped and prevented from scattering. The unfiltered micro and macro particulates still present in the air get captured in HEPA Filter. The micro particles and microorganisms like bacteria; fungus etc. up to a level of 0.03 microns will be filtered. With an efficiency of about 90 %. The UV light kills the microorganisms that pass through.

COMPARISON OF AIR QUALITY TESTED BEFORE AIR FILTERING & AFTER AIR FILTERING			
	Before filtering	**After filtering**	**% Purification**
CO	200	20	90
NO_x	190	14	92.6
TVOC	146	16	89.04
Particulate matter in ppm	130	13	90

Table -1: Analysis of purification efficiency

*TVOC-Total Volatile Organic Compound

Air sample is tested for quality of air filtering through the designed system. Initially the environment air from a room is tested for its air quality. The readings are taken in a testing machine. Afterwards the environment air made of same room is passed as input air to the air filter device. The readings are taken again from testing machine. The difference of initial and later readings is taken and compared as shown in following Table No. 1.Chart 1 shows the experimental analysis of purification efficiency.

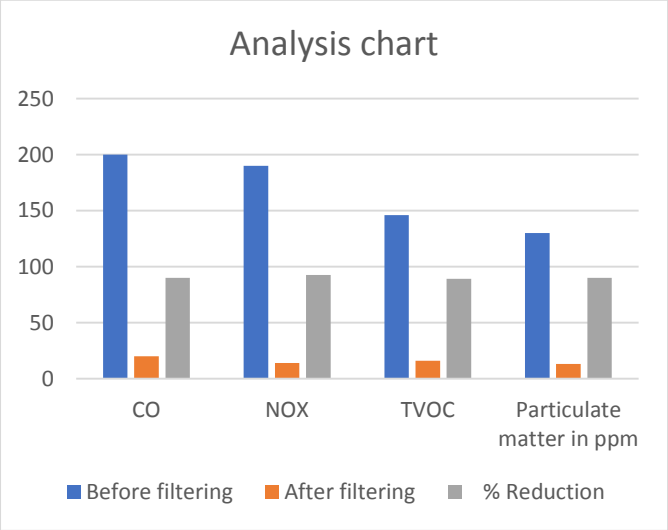

Chart -1: Analysis of air purifier efficiency

Fig -1: Air purifier system

4. CALCULATION

4.1 Clean Area Delivery Rate (CADR)

Clean Air Delivery Rate (CADR) is measured as cubic meter (m^3) of air filtered per hour or cubic foot (ft^3) of air per minute. In other words it indicates rate of air

Purification in volume per unit time. Higher purification rate means higher CADR value which is good. It is suggested to have CADR number as 3 by Association of Home Appliance Manufacturers

(AHAM) for pollen, dust, smoke and tobacco removal on an air purifier.

CADR value = Square Feet of Room / 1.55

Area of Room = 275 sq.ft.

CADR value = 275 / 1.55 = 161.29 m^3/hr.

4.2 Air Change per Hour (ACH)

ACH means how many times the complete volume of air inside a room repeatedly gets filtered per hour. If the purifier filters the air in the room three times an hour.

4.3The ACH index reflects the effectiveness of the air purifier.

CADR = 161.29 m^3/hr.

CADR = 300 x 0.588 = 104.19 ft^3 / minute

Air changed in an hour = 104.19 x 60 = 6251.4 (CADR in CFM x number of minutes in an hour)

Room volume= 2475 (275 x 9), as Room height is assumed to be 9 ft.

ACH rating = Air changed in an hour / Room Volume

ACH rating = 6251.4 / 2475 = 2.56

5. MERITS & FUTURE SCOPE

i] The designed air filter is highly efficient and removes fine size particulates of micron size.

ii] Even the continuous usage of HEPA filter will not allow accumulated pollutants from filter

iii] The designed filter does not produce harmful gases during filtering.

iv] As it removes all types of solid and gaseous pollutants, it is highly useful in hospitals, operation theaters, and indoor houses where it is required to maintain high standard of air quality index.

v]In general the air condition systems does not remove chemicals in gaseous state, or odor from air effectively but if we incorporate the air filtering system with air conditioner, the output air will become highly purified.. The air conditioner the filtered air can be sent to air conditioner so that the load on the air-conditioner will be reduced. In other words, output of this filter may be connected to input duct of air conditioner for effective air conditioning.

6. CONCLUSIONS

Air purifiers developed on various technologies are available in the market. Advanced air purifiers use combination of technologies to enhance air purification. The HEPA types of filters remove viruses from air during purification. Some versions also remove the micro dust particles as well pollen contents from air. HEPA filters manufactured under set standards may have highest

efficiency around 90 %. They filter even 0.03-micron size particulates from air. The analysis of air quality after filtration indicates that the designed combination of different air filters results in good air quality index of purified air.

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