

DESIGN AND DEVELOPMENT OF ROOM AIR PURIFIER

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Abstract - Population density increased by the social development in cities, contributing to extreme air contamination in the inside. As a result of these developments, greater attention has been paid to the problem of safe and balanced indoor environments. To enhance the indoor air quality, various air purifying techniques were adopted. Air filtration technique can eliminate air contaminants and effectively reduce worsening air quality indoors. This report provides a detailed analysis on the cooperative impact of various techniques for air filtration theory, components, and regulations. It analyses various technologies of air purification, taking into consideration like improvement of air quality, Filtrating efficiency, thermal comfort and acoustic impact, energy and financial behavior. present research development of air purifying technologies will be discussed along with their challenges, advantages and limitations. This report aims to drive research and development into the future of air purifying technology in achieving sustainable and healthy ventilation in buildings.

Key Words: activated carbon, ionic filter, UV filter, carbon filter, air quality, pollution

1. INTRODUCTION

In the present scenario pollution become very serious because of urbanization all around the world. So, we need to concern about it because everyday activities are associated to the environment. Make sure the condition is under control government established monitoring facilities to know the current condition. Air pollution is most important problem of the environment, which mainly concentrates in cities. So, we see many cities has develop with the progressively industrialization and urbanization. air quality standards refer to PM (particulate matter) with a diameter smaller than 10 μm .

These fine particles are main concern for us because this are capable of easily transported over long distance by the flow of air. And this particles causes respiratory health problems and the recent studies shows that PM2.5 particles can penetrate to deepest part of the lung so this is the major concern for us that's why make a activated carbon air filter which is used to remove this harmful particles from the atmosphere for better health and atmosphere so the main objective of this project to provide affordable activated carbon filter to the house uses and many more

2. AIR QUALITY

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2.1 Measurement of air quality

Measurement of air pollution by the chemical and physical ways and additional refined electronic techniques.

1. Passive sampling is the technique in which involving observing techniques which uses collected medium like man made devices and biological organism and collect these pollutants from the surrounding over time and this indicates the average pollution level over a time of weeks or months this technique is reliable and mostly cost efficient
2. Active sampling technique in which the impure air collects by the chemical or physical way and examine this collected air later in the laboratory
3. Automatic ways like many sites gives 24 hours data of air quality. They measured air hourly and once sample is analysed this downloaded in periods of time this provides correct info.
4. Remote sensing method this technique collects information from the earth surrounding by the help of physical sample or touching the surface by the help of sensors placed on a given platform some distance from it. This sensor calculates the energy return from the earth. This info. Present as a digitally generate images.

These sensors can be fitted on the satellites which are orbiting earth but this technique only used in the day time for example ground level gas may measure by the jps series of satellites, GOES-R series satellite gives us report of air pollution roughly each 5 minutes throughout the day.

- Indoor air quality sensors are the device which is used for the measure the pollution level inside and around the building, this is very helpful for sophisticated residential and commercial building because this give the exact level of the AQI (air quality index)

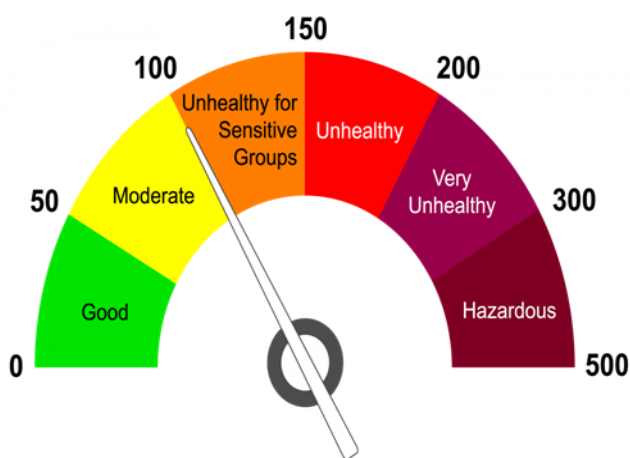


Fig -1: Air quality standards

Table -1: Data related to air quality index in some metro cities in different time

CITIES	27-10-2019	08-06-2020
DELHI	345	115
MUMBAI	45	45
BENGALURU	47	36
PUNE	83	57
NAGPUR	78	52
CHENNAI	280	89
HEYDERABAD	41	92
PATNA	151	69
KOLKATA	188	49

3. FILTERS AVAILABLE TO PURIFY AIR

Air filters are device that take away particles, like dirt and VOC (volatile organic compounds) these filters give you good air quality. So, if we see that there are many types of filter available on the market but all have some unique property to ensure you to provide good air for example ionic, carbon, UV air filter and HEPA they are usually employed at the economic, commercial sectors

3.1 Ionic air filter

Ionic air filter we also say that air ionizer. They are different from the filter because of their work as a negative ion generator. They release a negative ion charge which attached to the pollutants and this bond particle falls down due to weight. By this filter, particles may not be in air, but these particles still present in the room until you vacuum out this particle.

3.2 HEPA air filter

The term HEPA stands for high efficiency particulate air and what that basically means is its special type of filter that captures microscopic particle these particles include things the dust, pollen, bacteria etc. and particulate matter that corners from outdoor air pollution. Heap air cleaners are devices that clean the air by removing microscopic contaminants. this lead to cleaner, fresher air to breathe. HEPA filters catch particle which are size of 0.3 microns or large and it almost take away up to 99.97 % of small particles.

3.3 Carbon air filter

It's been specially treated with oxygen to open up the pores of the carbon atoms. What this process does is increase the total surface area of the charcoal so it can capture certain particles from the air. those particles include odour and gas molecule. as odours and gases pass through a carbon filter the molecules react with the charcoal and stick to the surface. essentially this removes bad smells and chemical gases from indoor air from things the pain, volatile organic compound and more. Particles which captures by the carbon are carbon monoxide, nitrogen oxides, sulphur dioxide, lead and particulate matter.

3.4 UV air filter

UV light is designed for one purpose to kill airborne bacteria and viruses. As air passes through the air purifier, he UV light shines on the microorganisms and pathogens, and this destroys their DNA structure. after the air is sterilized, those germs are harmless to your health. Wavelength of these rays are 264nm

Table -2: Comparison of different types of filter

TOPIC	IONIC PURIFIER	HEPA PURIFIER	ACTIVATED CARBON	UV FILTER
PROCESS OF AIR CLEANING	Air particles being charged, then these particles are accumulated in plates, then the air flows through the fan of the filter.	Air is forced to the filter where particles are being trapped.	Activated charcoal removes pollutant particles present in air, This process is called adsorption process.	UV filter eliminate germs, bacteria in the air pass through the filter
OZONE PRODUCTION	Very small (9 <0.05ppm typical)	No	After saturation point of carbon	No
GERM KILLING ABILITY	Depends on the product.	Not necessary.	50% to 70%	High
AIR FLOW RATE	Often low.	Medium to high (Can be adjust speed of the fan)	Medium to high	Adjustable to good to high
DUST CLEANING	Low	satisfactory	satisfactory	None
CIGARETTE SMOKE CLEANING	Satisfactory (0.01uM)	Particle size more than 0.3uM	Good	good
ODOR REDUCTION	Poor/moderate	Medium	High	Good
PET DANDER CLEANING	High	Medium	Medium	Low
ALLERGY RELIEF	High	Medium	High	Low
FILTER MAINTENANCE	We can reuse the plate after cleaning.	We have to replace within 6 to 8 months.	Change after carbon plate fully saturated	Uv lamp change after 9000 hours or about 12 months
AVERAGE COST	\$50-\$65+	50\$-100\$+	\$100-\$190+	\$49-\$150+

4. POPULAR FILTERS IN MARKET

Generally, combination of HEPA filter & ionized filter or Combination of HEPA filter & UV filter or combination of all four is used to purify air.

5. FILTER WHICH WE ARE GOING TO USE

basically we used activated carbon filter with HEPA so activated carbon which are generally used in water for removing impurities by the method of adsorption we made a model of activated carbon filter and give some calculation of this design basically we used very normal things to developed this model which easily affordable for all families.

6. HOW ACTIVATED CARBON WORKS

Carbon air filters are the channels most generally used for evacuating harmful gases they are removed by the carbon plate likewise activated carbon they are normally used to trap VOCs which are comes out from the many basic items used in house.

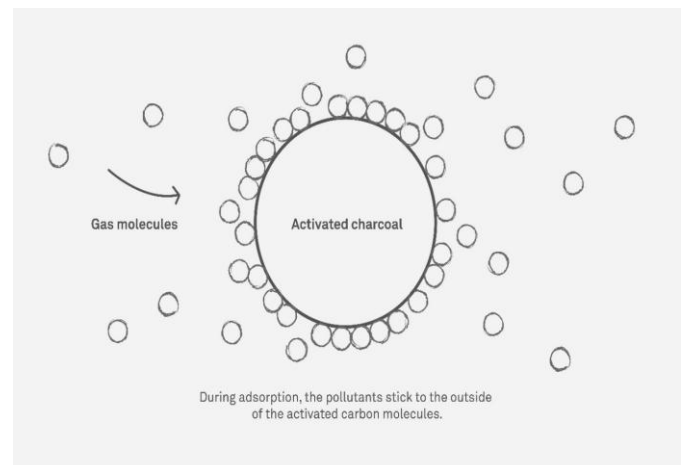


Fig -2: trapping of gaseous pollutants

6.1 Trapping of gaseous pollutants in activated carbon

Basically we have to know that carbon air filters how its reduce pollutants from the air by the process of adsorption this is totally different from absorption so in the process of absorption for example water which is soaked by the sponge that means water is present inside the sponge that means it become the portion of the absorbent which is not secured and it merely fills inside the areas among it.

So, carbon filter used adsorption process in this process it allows carbon air filter to filter organic chemicals from the air these gaseous pollutants fill up by the area of activated carbon if the carbon is saturated it's no longer trap pollutants

Table -3: adsorption efficiency of different activated carbon

Material	Adsorption efficiency
Bamboo based carbon	70.9%
Bamboo charcoal	72.3%
Coconut shell charcoal	51.6%
Phosphoric acid activated carbon	34.7%
Charcoal based	47.6%
Pecan shell	50.6%

Table -4: Comparison between types of activated carbon

S. NO	Characteristics	Coconut activated carbon	Coal activated carbon	Wood activated carbon
1	Density of material	Generally, 0.480-0.58 gram per cubic cm (high)	Generally, 0.38-0.48 gram per cubic cm (medium)	Generally, 0.25-0.30 gram per cubic cm (low)
2	Hardness of material	Approx. 98% (high)	Approx. 90 - 95% MIN (medium)	Approx. 85% MIN (low)
3	Maximum ash present in material	Approx. 3%	Approx. 10%	Approx. 15%
4	Porosity of material	Microspores are more	Microspores are more & less mesoporous	Both mesoporous & microporous are more
5	Weld ability of material	Very good	Good	Poor
6	Existence of heavy metals	Cannot trace	Exist	Exist in low quantity
7	Effect of washing back	Loss of material is very less	Loss of material is less	Loss of material is less
8	Operational expense	Less	medium	High
9	Source	From the by-product of agriculture which are renewable	Found from fossil which are available in limited quantity	High availability but will be exhaust

10	Maximum use	Process of dichlorination	For removing of odour	For decolorization
11	Application of material	For Water treatment process	For effluent treatment	For ETP

7. DESIGN OF MODEL

7.1 Materials and equipment required:

1. Activated Carbon plate of 30cm*30cm.
2. Blower/Fan of 205 CMH.
3. HEPA Filter of 30cm*30cm.
4. Air Quality measuring device
5. Wooden box of 32cm*32cm*20cm.

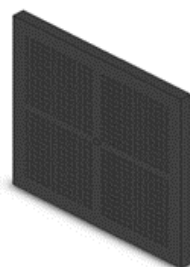


Fig -3: Activated carbon



Fig -4: HEPA filter



Fig -5: Fan



Fig -6: air quality measuring device

7.2 Calculation

$$\text{Air Flow Required (CFM)} = \frac{\text{Volume} * \text{Frequency}}{60}$$

{for living room frequency = 6 per hour

{Volume = 12x10x10 feet³

$$= \frac{12 * 10 * 10 * 6}{60}$$

$$= 120 \text{ CFM}$$

$$= 205 \text{ CMH}$$

Dimensions of our filter: -

Length = 32 cm

Width = 32 cm

Thickness = 20 cm

7.3 Model of our design

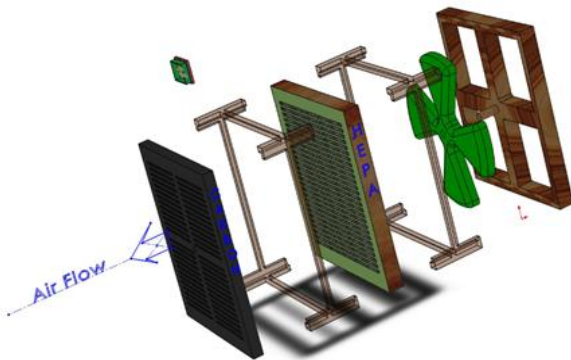


Fig -7: Exploded view

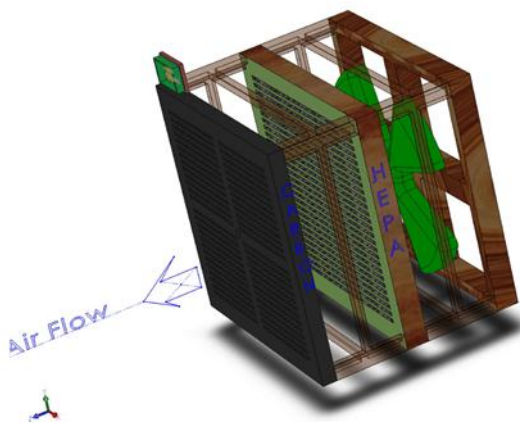


Fig -8: assembled view

7.4 Cost analysis of our design

1. Cost of activated carbon plate that used = Rs.1000
2. Cost of HEPA Filter = Rs.500
3. Cost of Fan = Rs.450
4. Cost of Air quality measuring device = Rs.4999
5. Miscellanies = RS.100

Table -5: Comparison of our model with existing model

S No.	Existing model	Our Model
1.	Costly	Cheap
2.	Complex & Fix Design	Simple & Flexible Design
3.	Running cost is high	Low Running Cost
4.	Long life	Life is short (Approx. 2 month)

8. APPLICATION OF AIR FILTER

We can use this filter in

1. Living room
2. Cabin
3. Hospitals
4. Schools
5. In industries etc.

9. DISADVANTAGE OF THIS FILTER

1. We do not get exact time, of saturation of carbon.
2. Activated carbon will not absorb sodium (Na), Heavy metals Nitrates & fluoride.
3. Its life is short.

10. CONCLUSION

Because we cannot get exact information about when activated carbon plate is saturated, we have to check it after certain period of time. This activated carbon filter is very much useful in current situation of surrounding because air is most basic need for us.

11. REFERENCE

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