

Development of a Four Filter Air Purification System

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Abstract: All the air purifiers available in the market are still using a single filter, either Carbon or Electrostatic, for purification of air and even no research work had been done till date (as per data available) for checking the effect of various purification method combinations on the quality of air. So, the purifier which is fabricated by the researcher uses combination of air purification methods to improve the quality of air. Researcher is not only using Carbon and Electrostatic Filter but also going to install High Efficiency Particulate Air (HEPA) and UV Light Disinfection Method in the purifier and going to see the effect on the quality of air after coming out of this filter. So the Air Purification system cast off uses a combination of four purification filters namely: Carbon Filter, Electrostatic Filter, High Efficiency Particulate Air (HEPA) Filter and UV Light Disinfection Method

Key Words: Air Purification, Carbon Filter, Electrostatic Filter, HEPA, UV Light disinfection method, Pollutants

Introduction: Living in our innovative world, we once in a while consider the main thing. We can design robots doing our work and all moved toward becoming supervisors. Indeed, we can live in a house completely associated with us, so we don't need to push the catch to switch the lights.

Are these innovations most earnest today? Is it true that they are essential for our life making our regular day to day existence simpler, won't diminish disease among individuals. Truth be told, we will begin to feel the need of another innovation improving our wellbeing. We would prefer not to persuade you that innovation makes our life most exceedingly terrible. We need you to inquire yourself why we don't concentrate on the most critical parts of life –nature; joy; sound way of life; personal development and so on. Why we put more exertion and spend more cash on things that hurt us as opposed to focusing on what we can't live without. Nature! Are we endeavoring to create more advantageous nature – are we planting trees, are we shielding jeopardized species from termination. Rather than helping, we are pulverizing. We have officially made significant harm on nature and now is a great opportunity to attempt to reestablish its past wellbeing.

Be that as it may, it is exceptionally hard and takes incredible measure of time and exertion to imagine innovation, which can mend our inclination right away. In any case, with little advances we can accomplish our more prominent point. There are numerous advancements helping in improving our condition. Fig 1 below shows various outdoor pollutants available in the air:



Figure 1: Various Pollutants in Atmosphere

These days, one of the most concerning issues we face are identified with the contamination. The air we inhale has extraordinary effect on our wellbeing. We need to lessen smog in our urban areas. The main concern is to fabricate a system which cleans the air we inhale to the maximum levels as possible.

Kumar M.et.al designed and manufactured an air purifier system powered by solar power, and tested the system's efficacy in curbing air pollution. The emphasis is on removing from the air, suspended particulate matter which are major contributors to air pollution in many urban cities PM2.5 reading Purification percentage based calculations shows 89.4% reduction of AQI/AQI of incense stick.

Dey et al. examined how effective HEPA filtration is when an extremely high level of biological and particulate matter is removed from the air, when the pressure drops relatively low and when energy consumption is low. Such filters have been in use for decades and have been a valuable tool over the years to protect employees and equipment. Filtration is usually seen as separation from the flowing fluid by trapping the particulate matter into the tortuous structure of the filter medium. For Collective Protection Systems (CPS) particulate air filtration, high quality Particulate Air (HEPA) filters are used.

Wargocki P.et.al conducted a test to check effects on the consistency of childhood schoolwork in school classrooms for electrostatic particle filtration and supply air filters.. Two independent field implementation studies involving approximately 190 pupils have been carried out in the winter and early spring of 2005, which included five sets of mechanically ventilated classrooms receiving 100 percent natural air. There were different schools in every couple of classrooms. Electrostatic air purifiers have been built in classrooms and worked or disabled to modify particulate concentrations when the school's output is assessed. For one school, the air filters used in a recirculated ventilation system were replaced by new ones, which altered the air quality of the classroom air, whereas the filters used in other schools were not altered. The treatments were planned for one week at a time and repeated procedures were made in a blind hybrid system for children aged between 10 to 12. Throughout normal classes, students completed six assignments, which highlighted different aspects of schoolwork, demonstrating their world experiences and the seriousness of any symptoms. Soon after the students left the classrooms a sensory group of adults assessed the air quality.

Aggarwal S. et. al. investigated the effects that air cleaners continue to controversial on the removal of indoor airborne allergens, especially house dust mites (HDM). This research is intended to determine the effect on the reduction of allergens from airborne mites by an air purifier with a electrostatic filter. An electrostatic air cleaner, containing mite particles and excretions, was applied in a chamber with a dried HDM culture medium. A dust spectrometer measured the number of airborne particles continuously for 60 minutes. Airborne chamber particles were collected at a sampling filter rate of 10 L / min, and two-site ELISA was performed to determine the Der f 1 concentration in the filter extracts. He found that the electrostatic air cleaner can remove allergens from the airborne HDM and is useful as a supplementary environmental control device for patients with HDM-sensitized allergies. After reviewing a lot of research work done by various researchers very little research has been found which uses UV air filter till date. So researcher is implementing this method/device research using certain parameters.

Methodology: A five step methodology is used to fabricate the system of air purification:

Step 1: What all is Needed

- A Nano protect activated carbon filter – width-28cm, height-36cm dimensions
Manufacturer – Philips
- 1 Fan, Home appliance A.C. supply – 220/230V, 1400rpm
An AC/DC adapter, with a DC output the same as your fans.
- 1 HEPA Filter by Philips, filter out 99.5% particles as small as 0.2 microns.
Dimensions – Width-27cm, height-35cm
- UV lamp Filter with choke – diameter -1.5mm, length- 20cm.
- Electrostatics Filter – Width-21cm, height-32cm.
- 1 Steel Sheet Box - L-49cm, W-33cm, H-40.5cm.

TOOLS NEEDED

- Drill and various bits.
- Wood hammer.
- Soldering iron + Solder
- Hot glue gun + Sticks
- Nut and bolts

- Double side paper tape
- Steel sheet cutter
- Steel Ruler

Step 2: Preparation

Start by Steel ruler, with desired dimensions cut the Galvanized Iron sheet with the help of sheet cutter. Now with the help of soldering iron and solder the sheets which are cut are made in a form of a cubic box. Create opposite holes on 2 sides of the cubic box, bigger hole for fitting the fan and other for the HEPA filter.

Step 3: Assembly Part 1

HEPA filter would be placed to the one side of the box as the above shown figure with the help of hot glue gun. In the opposite side fan is placed with the help of drill and drill bit, further they are fixed with nuts and bolts. Also holes are created for the wires of the adapter, and the wires of the fan. One thing is to be kept in mind that holes are placed close enough to the top so that enough space is their to install the fan. In the gap between the fan and the heap filter other filters are placed.

NOTE: All filters are not of equal length; therefore foam is used so as to get the desired output.

Step 4: Assembly Part 2

The upper end of the box is also made for vibration control, ease of transportation also for the safety of the parts of the air purification system. The UV lamp tube attached with the choke wires are placed inside the foam as they are quite delicate and can easily be destroyed, we've used two UV lamp tube.

Note: Foam is also important for the safety of the system.

Step 5: Assembly Part3

All the other filters would now be put in this box vertically. Filters are kept to some distance with each other for getting high efficiency. Other filters include UV lamp filter, carbon filter and electrostatic filter.

Plug it in, it is extremely quite and blows with the desired output. Set it somewhere in your room or any area, and let it clean your air.

Fabrication of Air Filtration System:

The Case: A cubic box with the help of Galvanized Iron sheet, steel sheet cutter, ruler, drill and drill bits, soldering iron, solder is developed and used as the case for the air purification system installation, as shown in figure 2 below:



Figure 2: The Case

HEPA Filter: HEPA stands for **High-Efficiency Particulate Air**. Therefore it is a filter that is usually included as part of air purifying machines or vacuum cleaner to collect minute elements of dust or microorganism. HEPA air purifier not only removes pollutants from the dust but also stops them from transmitting other bacteria and viruses that can destroy our organs. True HEPA air purifier is effective in trapping particles as small as 0.3 microns at around 99.97 per cent. It is thus the most effective filter used in vacuum cleaners these days which helps us to breathe in fresh and pure air. It is also known as the material of luxury home. The standard form of filter acts as a strainer that has small holes to trap large particles like dust, dirt, and hair, but with the aid of these filters, the small

particles can not be caught. Therefore, HEPA air purifier was primarily implemented to filter the smaller particles out of the air. Fig 3 below shows the HEPA filter used for the research work:



Figure 3: HEPA Filter

UV Lamp Tube Filters: UV air purifiers are designed to use ultraviolet short-wave light (UV-C light) for inactivating airborne pathogens and micro-organisms such as mold, bacteria and viruses. The same ultimate goal for all air purifiers: to reduce air pollution in indoors. Often called UV germicidal irradiation, or UVGI air purifiers, the device is named. This is different from other technologies for air purifier which involve UV light technology but do not use it directly against air pollutants. Fig 4 below shows the UV Filtration method used for the research work:



Figure 4: UV Filtration Method

Activated Carbon Filter: Carbon filters are small carbon bits, usually in the form of granules or powdered blocks which are extremely porous. However, only 1 gram of activated carbon can easily reach an area of 500 m² or more. Such carbon filters allow large areas to adsorb more contaminants and allergens exponentially than conventional oil. The adsorption process is a distinct mechanism in which organic compounds in the air or water chemically react to the activated carbon that allows it to remain in the filter. The more porous activated carbon is, more contaminants are trapped. Fig 5 below shows the carbon filter used:

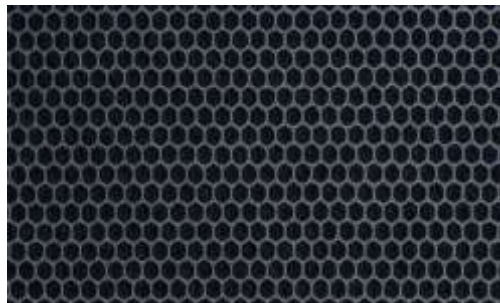


Figure 5: Activated Carbon Filter

Electrostatic Filter: An electrostatic air filter works within the ductwork of a HVAC system, effectively removing over 95 percent of the contaminants that float in the air. Such filters use a healthy electrostatic charge, which traps some of the smallest particles and contaminants in the air. For essence, the theory works in the same

way as a magnet, with the charges trapping dust into the pipes, making the air easier to breathe for everyone. Fig 6 below shows an electrostatic filter:



Figure 6: Electrostatic Filter

The Fan: An exhaust fan has been used to pull the air inside the filtration system from the atmosphere and shown in fig 7 below:



Figure 7: Exhaust Fan

Working Principle: Working principle used for the filtration system during research is shown in fig 8 below:

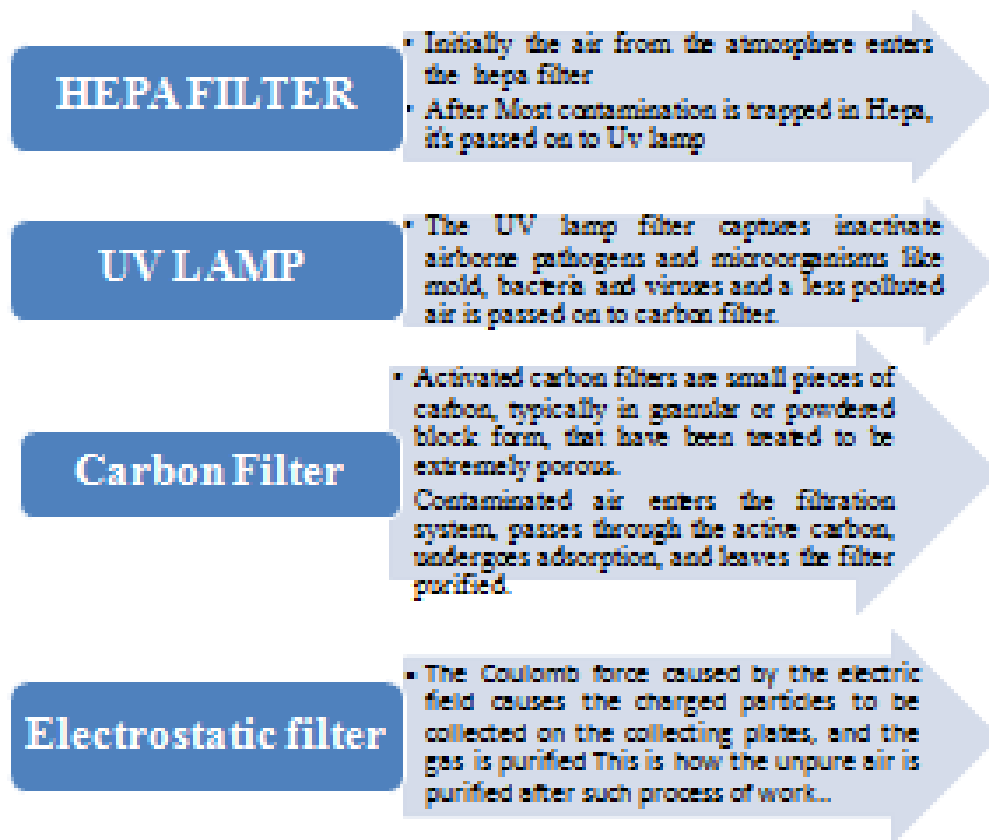


Figure 8: The Working Principle

Results:

Speed of exhaust fan $N=1200\text{rpm}$

Inlet air containing pollution like dust smoke and mist. = 36

Clean air from inlet containing pollution = 0.27

Efficiency of purifier = $0.27/36 \times 100$
= 75%

Conclusion: From the fabrication of air purifier using the combination of four filter researcher is able to achieve some of these results:

- The efficiency Air Purifier came out to be 75 %., which indicates its conformation and scope in various applicable areas. It was able to eliminate a range of contaminants from the air in vary small amount of time.
- Secondly, It was also able to trap 99.97% particles have size greater than 0.3 microns. which depicts its precision in elimination of soot particles because of HEPA purifier.
- Due to the implementation of UV tubes or filter, purifier is able to remove the microbes and viruses present in moist air.
- Activated Carbon further extends its dimensions of efficiency by absorbing various unwanted particles.

Future Scope:

- This project has a wider scope for commercial application in cars, homes as well as corporate sectors.
- It is the need of an hour in the cities like Delhi which has highest rate of air contamination.
- Higher contamination leading to several health problems, in result short span of life.
- We can use acid rain absorber to to trap the acidic substances present in moist air.
- We can used solar panels to run the purifier.
- We can used ionizer filter to trap the dust particles which are less than 0.3 micron size

- This project has a wider scope for commercial application in cars, homes as well as corporate sectors.

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