



# Design Silent Air Purifier And Humidifier Using Water Filter

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## **Abstract:**

Poor indoor air quality is commonly found in homes in larger cities, and it's result of a growing industrialization that pollutes air we breathe with contaminants like industrial dust , smoke and other particles from traffic. The solution from user perspective, is to use an air purifier that clean the air from these particles inside the users home. An air purifier can also be used to ease annoyance for people suffer from allergies. This matter thesis concerns the design and development of the next generation of the air purifier for indoor use. The project has been conducted with human centre design process and co-design approach. The development of this project contains several methods commonly used in order to achieve a result that is trustworthy and in line with user needs. The project also resulted in a patient application for new type of filters that the user can clean without the need of continuous buy of new filters. The filter also consumes less energy is smaller and more compact than competitors on the market. This leads to less material use which results in less negative environmental impact. The use of air purifiers to filter polluted or contaminated air, seems an interesting solution nowadays. Using an extensive experimental approach, a commercial air purifier was tested under real conditions in-situ. The IAQ was measured in two rooms: living room and bedroom for different air change rates of the air volume. Measurements of PM2.5, PM10, relative humidity, air temperature and sound pressure level were made. It was found that the PM2.5 levels are quickly reduced from 20.64  $\mu\text{g}/\text{m}^3$  and decreased to 5.58  $\mu\text{g}/\text{m}^3$ . The research was also focused on the noise levels measurements and it was noticed that in Silent to Low mode (60 and 150  $\text{m}^3/\text{h}$ ) the sound pressure levels are under 30 Db . Overall, the use of air purifiers in homes is recommended nowadays.

**Keywords:** Air purifier, Purification technology, Experimental measurements, Relative Humidity, Sound pressure measurements, Fine particulate matter, Indoor air, Dust exposure.

## **INTRODUCTION:**

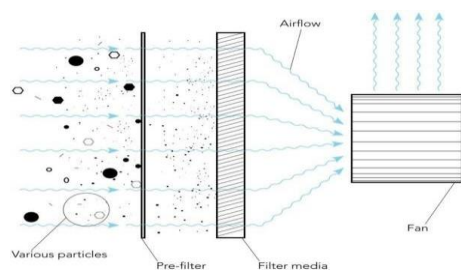
**AIR PURIFIER:** An air purifier or air cleaner is a device which removes contaminants from the air in a room to improve indoor air quality. These devices are commonly marketed as being beneficial to allergy sufferers and asthmatics, and at reducing or eliminating second-hand tobacco smoke. The commercially graded air purifiers are manufactured as either small stand-alone units or larger units that can be affixed to an air handler unit (AHU) or to an HVAC unit found in the medical, industrial, and commercial industries. Air purifiers may also be used in industry to remove impurities from air before processing. Pressure swing adsorption or other adsorption techniques are typically used for this.

**HUMIDIFIER:** A humidifier is a device, primarily an electrical appliance, that increases humidity (moisture) in a single room or an entire building. In the home, point-of-use humidifiers are commonly used to humidify a single room, while whole-house or furnace humidifiers, which connect to a home's HVAC system, provide humidity to the entire house. Medical ventilators often include humidifiers for increased patient comfort. Large humidifiers are used in commercial, institutional, or industrial contexts, often as part of a larger HVAC system.

Low humidity may occur in hot, dry desert climates, or indoors in artificially heated spaces. In winter, especially when cold outside air is heated indoors, the humidity may drop to as low as 10–20%. This low humidity can cause adverse health effects, by drying out mucous membranes such as the lining of the nose and throat, lead to a snoring problem, and can cause respiratory distress. The low humidity also can affect wooden furniture, causing shrinkage and loose joints or cracking of pieces. Books, papers, and artworks may shrink or warp and become brittle in very low humidity.

**BASIC PRINCIPLE:-**

An air purifier is usually equipped with a fan that absorbs air and lets the air pass through a filter media where particles get - stuck. Usually there is a pre-filter that captures larger particles. Behind the pre-filter, some air cleaning technology, usually a finer filter, captures smaller sized particles (Figure 1). The air that comes through is clean from harmful particle



**2 AIR PURIFIER**

An air purifier is a device which removes contaminants from the air in a room. These device sare extremely beneficial for allergy sufferers, asthmatics and at reducing or eliminating second-hand tobacco smoke. They are also extremely useful for reducing pollutants from a room if you live in a highly polluted environment, for instance New Delhi, Patna or Gwalior; which are among the most air polluted cities in the world. They also help eliminate virus and bacteria from a room which prevents the spread of disease.

**USES AND BENEFITS OF AN AIR PURIFIER**

Dust, pollen, pet dander, moule, spores, and dust mite faces can act as allergens, triggering allergies in sensitive people. Smoke particles and volatile organic compounds (VOCs) can pose a risk to health. With the advancement in air purification technology, air purifiers are becoming increasingly capable of capturing a greater number of bacterial, virus, and DNA damaging particulates. Air purifiers are used to reduce the concentration of these airborne contaminants and can be useful and fruitful for who suffer from allergies and asthma.

**Objectives**

The Objectives of our work are :

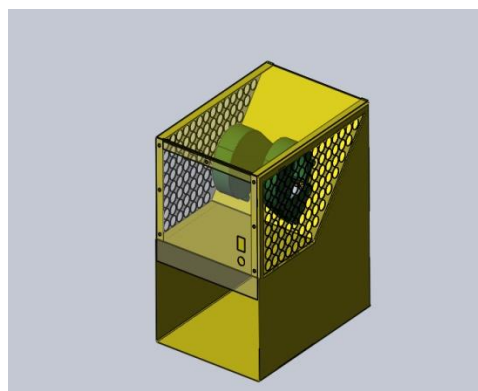
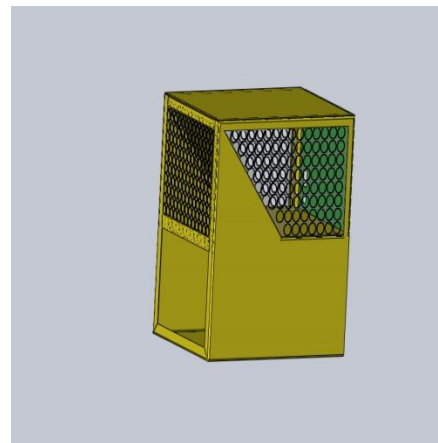
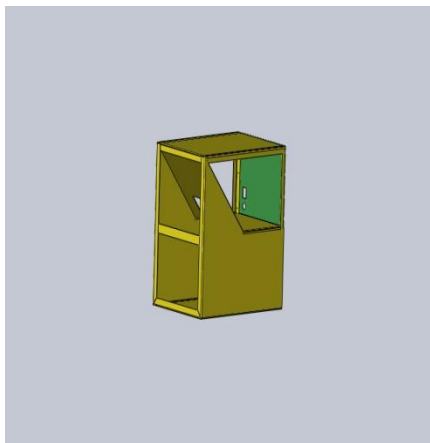
1. To cater to the issue of competition in the mechanical industry the need for automation is assessed by all the industry.
2. To identify the key policy avenues considered to be appropriate to meet the challenge of sustainable manufacturing and packaging industry for the future.
3. To provide alternatives for industries aiming toward reducing human effort and improvement in material handling systems by implementing automation.
4. Sustainable and practical automation solutions for the future industrial environment.

**PARTS OF SILENT AIR PURIFIER AND HUMIDIFIER:**

- **Centrifugal Fan 12V:** A centrifugal fan is typically used for residential applications to move air through a duct in your home. Think of your air conditioning system, furnace, or range hood duct. You also might see these in commercial environments like your car wash. A DC motor uses an internal arrangement of magnets with opposing polarity. As current passes through the coil around this arrangement, a strong magnetic field is produced. This magnetic field then creates a torque that causes the motor to rotate.



- **Adaptor or Transformer** :- main purpose of adaptor is to convert alternate current (AC) to direct current (DC).
- **Pipes:-** The pipes are attached to the air blower pumps. it transports the air from air blower pumps to water tank.
- **Nozzle:-** Nozzles are attached at the end of the pipes which are used to increase the velocity of the air.
- **Mounts and joints** :- these mounts and joints are used to create a base for the air blower pumps.
- **Base frame:-** Base frame is used to create a base for the system.
- **Supporting frame:-** these are used to support the system and also as side frames of the system.
- **Screws and fittings:-** Screws and fittings are used to combine the parts of the system.
- **Water tank:-** water tank is used to store the water.

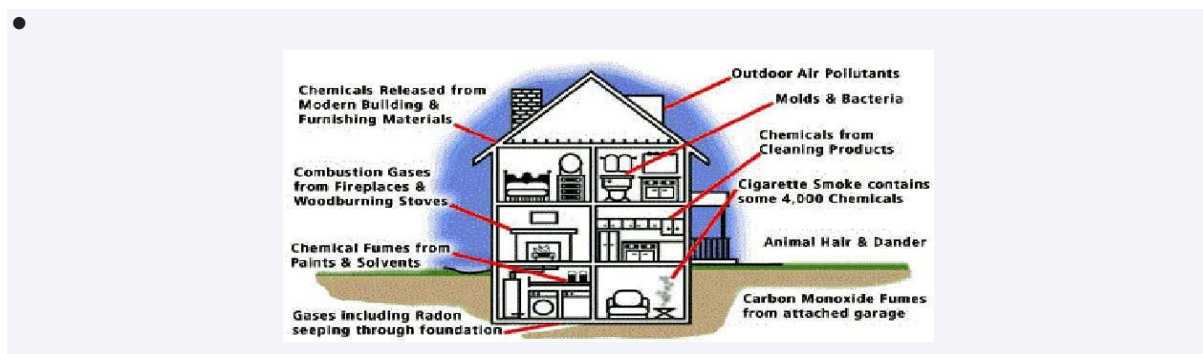


## RESEARCH METHODOLOGY

- Initially we supply current to the system (230v, 10 Amps).
- Adaptor converts the AC current to DC current and supplies it to the air blower pumps.
- Air blower pumps converts the electrical energy into mechanical energy and the fans starts rotating. Due to rotation of fans it sucks the air from atmosphere.
- And that air is transported to pipes by air blower pumps.
- The pipes transports the air to the water tank. At the end of pipes nozzles are fitted which are used to increase the velocity of the air.
- And the air enters into water. Water eliminates the impurities like dust, fungus etc from the air .
- Due to water the humidity percentage of the air gets increased.
- This purified and humidified air comes out from the system.

## USES AND BENEFITS OF AN AIR PURIFIER

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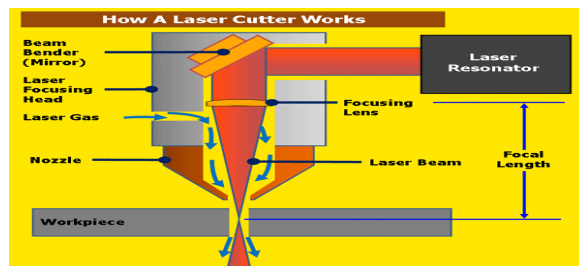


## Fabrication Processes used :

### Laser Beam Machining (LBM)

Lasers are used for many purposes. One way they are used is for cutting metal plates. On mild steel, stainless steel, and aluminum plate, the laser cutting process is highly accurate, yields excellent cut quality, has a very small kerf width and small heat affect zone, and makes it possible to cut very intricate shapes and small holes. Most people already know that the word "LASER" is actually an acronym for Light Amplification by Stimulated Emission of Radiation. The laser beam is a column of very high intensity light, of a single wavelength, or color. In the case of a typical CO<sub>2</sub> laser, that wavelength is in the Infra-Red part of the light spectrum, so it is invisible to the human eye. The beam is only about 3/4 of an inch in diameter as it travels from the laser resonator, which creates the beam, through the machine's beam path. It may be bounced in different directions by a number of mirrors, or "beam benders", before it is finally focused onto the plate. The focused laser beam goes through the bore of a nozzle right before it hits the plate. Also flowing through that nozzle bore is a compressed gas, such as Oxygen or Nitrogen. Focusing the laser beam can be done by a special lens, or by a curved mirror, and this takes place in the laser cutting head. The beam has to be precisely focused so that the shape of the focus spot and the density of the energy in that spot are perfectly round and consistent, and centered in the nozzle. By focusing the large beam down to a single pinpoint, the heat density at that spot is extreme. Think about using a magnifying glass to focus the sun's rays onto a leaf, and how that can start a fire. Now think about focusing 6 KWatts of energy into a single spot, and you

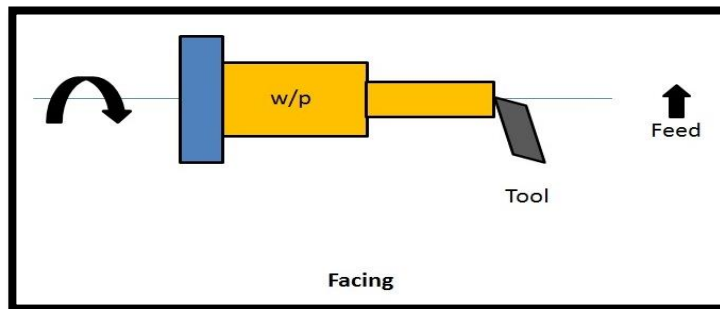
can imagine how hot that spot will get. The high power density results in rapid heating, melting and partial or complete vaporizing of the material. When cutting mild steel, the heat of the laser beam is enough to start a typical “oxy-fuel” burning process, and the laser cutting gas will be pure oxygen, just like an oxy-fuel torch. When cutting stainless steel or aluminum, the laser beam simply melts the material, and high pressure nitrogen is used to blow the molten metal out of the kerf. On a CNC laser cutter, the laser cutting head is moved over the metal plate in the shape of the desired part, thus cutting the part out of the plate. A capacitive height control system maintains a very accurate distance between the end of the nozzle and the plate that is being cut. This distance is important, because it determines where the focal point is relative to the surface of the plate. Cut quality can be affected by raising or lowering the focal point from just above the surface of the plate, at the surface, or just below the surface. There are many, many other parameters that affect cut quality as well, but when are controlled properly, laser cutting is stable reliable, and very accurate cutting process.



### Lathe Machine Operations:

#### Facing

Facing is the operation of machining the ends of a piece of work to produce flat surface square with the axis. The operation involves feeding the tool perpendicular to the axis of rotation of the work.



#### Taper turning

##### Taper

A taper may be defined as a uniform increase or decrease in diameter of a piece of work measured along its length.

Taper turning methods:

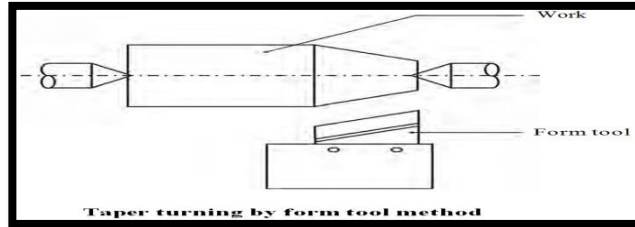
1. Form tool method
2. Compound rest method
3. Tailstock set over method

##### 1. Form tool method

A broad nose tool is ground to the required length and angle. It is set on the work by providing feed to the cross-slide. When

the tool is fed into the work at right angles to the lathe axis, a tapered surface is generated.

This method is limited to turn short lengths of taper only. The length of the taper is shorter than the length of the cutting edge. Less feed is given as the entire cutting edge will be in contact with the work.



## 2. Compound rest method

The compound rest of the lathe is attached to a circular base graduated in degrees, which may be swiveled and clamped at any desired angle. The angle of taper is calculated using the formula

$$\tan \alpha = \frac{D_1 - D_2}{2l}$$

Where,

$D_1$  &  $D_2$  = large and small dia. respectively

$l$  = length of taper

$\alpha$  = taper angle or the angle about which compound rest is swiveled

The compound rest is swiveled to the angle calculated as above and clamped. Feed is given to the compound slide to generate the required taper.

## 2. Tailstock set over method

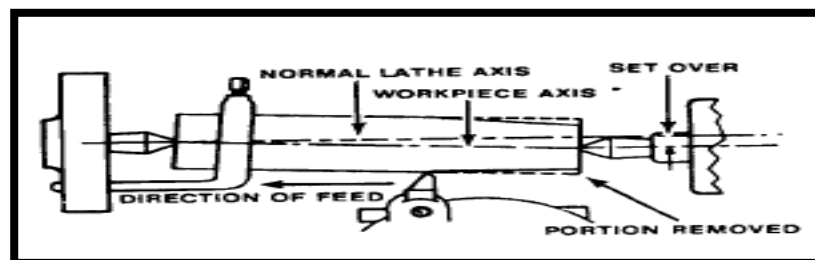
Turning taper by the set over method is done by shifting the axis of rotation of the work piece at an angle to the lathe axis and feeding the tool parallel to the lathe axis. The construction of tailstock is designed to have two parts namely the base and the body. The base is fitted on the bed guide ways and the body having the dead centre can be moved at cross to shift the lathe axis.

The amount of set over –  $S$ , can be calculated as follows

$$S = L \times \frac{D_1 - D_2}{2l}$$

The dead centre is suitably shifted from its original position to the calculated distance. The work is held between centres and longitudinal feed is given by the carriage to generate the taper.

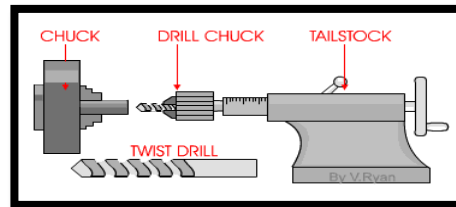
The advantage of this method is that the taper can be turned to the entire length of the work. Taper threads can also be cut by this method. The amount of setover being limited, this method is suitable for turning small tapers (approx. upto 8°). Internal tapers cannot be done by this method.





### Drilling operation:

It is the process of producing cylindrical hole in the work piece. In this operation, Work piece is held in a chuck or a suitable device and the drill is held in the tailstock. During operation, the drill is fed by rotating the hand wheel of the tailstock clockwise direction. First a shorter length is drilled by using a smaller and shorter drill, followed by producing the required diameter with the help of correct drill size.



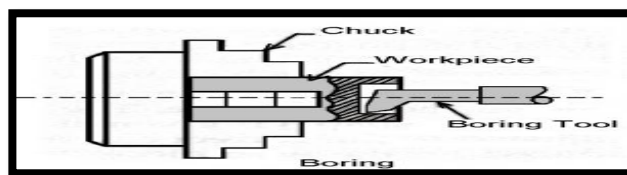
### Reaming Operation

It is a finishing operation because a very small amount of material is removed during the operation. For performing reaming a multi-teeth tool is used, which is called as reamer. During the operation, the workpiece is held in a chuck or face plate and the reamer shank is fitted in a sleeve or inserted in the tapered hole of the tailstock spindle.



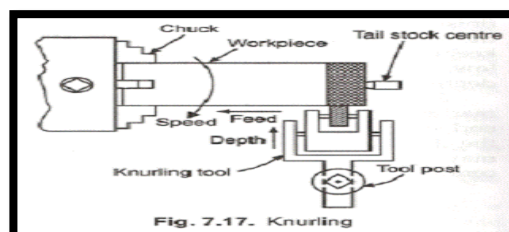
### Boring Operation:

It is an operation which is employed for machining internal surfaces, hence also called as internal turning. Boring is done to enlarge the already drilled hole and bring them to the exact required size. Generally, a single point cutting tool is used for this purpose.



### Knurling

Knurling is the process of embossing a diamond shaped pattern on the surface of the work piece. The knurling tool holder has one or two hardened steel rollers with edges of required pattern. The tool holder is pressed against the rotating work. The rollers emboss the required pattern. The tool holder is fed automatically to the required length. Knurls are available in coarse, medium and fine pitches. The patterns may be straight, inclined or diamond shaped.



**Specification:**

**Table 1**

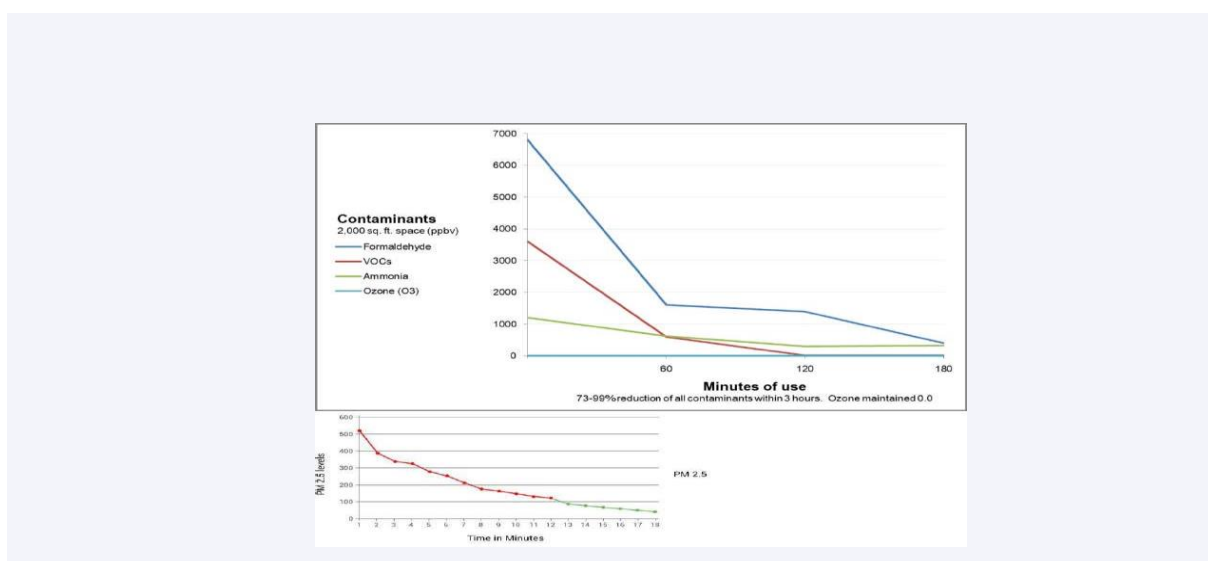
*Air purifier specifications*

Type	Specification
Weight	11
Air flow rate Turbo/H/M/L/Silent	450/330/240/150/60 m <sup>3</sup> /h
Humidifying operation Turbo/H/M/L/Silent	450/330/240/150/120 m <sup>3</sup> /h
Sound pressure level – Air purifier mode Turbo/H/M/L/Silent	50/43/36/26/17 dBA
Sound pressure level – Humidifier mode Turbo/H/M/L/Silent	50/43/36/26/23 dBA
Power input Air purifier Turbo/H/M/L/Silent	0.081/0.035/0.018/0.011/0.008 kW
Power input Humidifier mode Turbo/H/M/L/Silent	0.084/0.037/0.02/0.013/0.012 kW
Humidifier mode Turbo/H/M/L/Silent	600/470/370/290/240 ml/h
Water tank capacity	4.0 litres
Air filter	Polypropylene net with catechin
Dust collecting method	Plasma ionizer/Electrostatic dustcollection filter
Dimensions (Height x Width x Depth)	590/395/268 mm

**Working:**

When the power is turned on the fan present about the filters create a suction action in the empty space present below the filters. Due to this the surrounding air enters into this area and gets sucked into the filters. At first the air enters the cold catalyst filter and the air is purified from the harmful gases like formaldehyde, ammonia, ozone, benzene etc. Then the air enters the activated carbon filter, where the macro particles present in the air like dust particles get captured in the pores of the activated carbon. After exiting the activated carbon filter and getting most of the macro particles removed, the air enters the antimicrobial filter where the air is made to pass through an antimicrobial agent polypropylene membrane, where the microorganisms get stopped and prevented from spreading. Finally, the air enters into the HEPA filter where both micro and macro particles present in the air that escaped from the other filters get captured. Due to its close sieving of the fibers, the micro particles and microorganisms like bacteria, and fungus up to a level of 0.3 microns will be stopped with a 99.97% .





## CALCULATION

### 1. Clean Area Delivery Rate (CADR)

CADR is the abbreviation of Clean Air Delivery Rate. It is either measured as cubic meter of air delivered in hour or cubic foot of air delivered in a minute. Essentially, it is the indicator of how much air the purifier cleans in a given time.

Obviously, higher the better. The Association of Home Appliance Manufacturers suggest having three CADR number mentioned on each purifier, namely CADR for tobacco smoke, dust and pollen.

Smoke CADR value = Square Feet of Room / 1.55

Square feet of room = 275 sq.ft.

Smoke CADR value = 275 / 1.55 =

177.19 m3/hr

### 2. Air Change per Hour (ACH)

ACH simply is the number of times an air purifier filters all of the air in a room in one hour. So, an ACH rating of 4 means that the purifier filters the air in the room four times an hour. As you would have already figured out by now, it is one of the most important factor that signifies the effectiveness of the air purifier



CADR = 177.19 m<sup>3</sup>/hr CADR in cubic feet per minute = 300 x 0.588 = 104.19 cfm 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 =2.5

## **RESULT AND DISSCUSSION**

- HEPA filter remove 99.97% of particle that have a size of less than 0.02 micron.
- Composite filter consisting Cold Catalyst Filter and Activated carbon require frequent replacement after 6-8 month.
- Area Cover: About 275Sq. ft.
- Clean Area Delivery Rate: 175m<sup>3</sup>/h
- Air Change per Hour: 2.56
- Time required to purify air to a safe lever : 10-15min

## **CONCLUSION:**

The outcome of this project is a next generation air purifier with a new filter innovation. The new filter makes it possible to have a smaller housing compared with competitors but still having high performance. This means that it does not take up as much space and is easier for the user to move around from place to place inside the apartment; it is also equipped with a handle. The 360o Air is also easier to fit in more places in a home because its design does not restrict its position as much as competitors. That is, it has been given a round shape and have therefore no defined backside that needs to be placed towards a wall. The uniform round shape allows more varieties of how it can be positioned in a home. The filter is cleanable and does not need to be changed. The filter also has a low pressure drop which results in less generated noise and lower energy consumption. All these advantages that is the outcome of the new filter innovation makes this a product that stands out from competitors and makes it easy to sell for sellers and should generate revenue for the brand owners.

The air purifier is a product that solves the problem of bad indoor air quality. It is a problem that most of all have its effect on large cities and where the population is dense. Many cannot afford an air purifier and many have problem to cover the expenses of buying new filters. The 360o Air is a more socially sustainable than most competitors because it is cheaper in long term which results in more people being able to buy an air purifier that might be vital for their health. Even if the brand owners, manufacturers and sellers would not earn money from people regularly buying new filters, the 360o Air should still be economically sustainable because of the new filter innovation and its benefits that would attract more buyers. The fact that the 360o Air use less material than competitors will most likely also result in cheaper manufacturing. As mentioned before, the air purifier developed in this project is also more environmentally sustainable than competitors in the existing market.

## **Future Scope**

Increase in vehicular population, severe construction activities, and industries are largely contributing to an increase in outdoor pollution across Indian cities. It is quite evident that, with a growing economy and over 125 billion people to feed, the destruction will continue and more forests will be cut and space created for infrastructure. So there will be consequences for these actions. Starting from groundwater, the crops and the air they are all becoming toxic. Obviously, the coming generations will pay heavily for this irresponsible action by us. What we need are consciousness and actions that can at least



reduce the burden to the only planet that we have. While most of us have taken control of the food and water intake, but the air we breathe is ignored completely. Respiratory symptoms, especially among children are on the rise which signals in the effects of toxins that are causing severe damage to the respiratory system. It is also evident from the increase in your trips to the doctor or medication.

breathing air clean and purified by Sharp air purifiers reduce the number of toxins entering our body, thereby decreasing the need for medication or taking days off from work. This is missing from most brand commitments since they are too occupied with reducing dust or other particles and have diverted from the actual need and benefits that a consumer expects. Most people mistake the indoor air to be safe and free from pollution, however, due to poor ventilation and lack of sunlight, each and every activity that we do indoor contributes to adding toxins in the air we breathe. For example kitchen smoke, mosquito repellants, cleaning solutions, and electronic appliances they all contribute equally to poison the air we breathe. Apart from many other methods to reduce the airborne toxins in an indoor space like plants, air purifiers are gradually gaining momentum. However, due to lack of instant gratification or immediate result, the category has still not become popular among consumers. Each consumer, in spite of their problems, is afraid to take a decision that involves an investment of around 20K or more. As people's awareness increases and the demand for air purifiers rises, so does the requirement for advanced technologies. Almost all the leading brands spend a lot of time and resources on the R&D of their product and the air purifier market is expected to witness a rise in the demand of purifiers. At present, technologies such as air purifiers with mosquito catcher, car purifiers, and air sterilizers are already prevailing in the market, but the market for such products is still very small and limited. Currently, most Air Purifiers come with HEPA& Carbon Filters which can provide solution up to an extent and be going forward and as consumer awareness increases demand for higher technology marvels like Plasma cluster Ion Technology will be an accepted standard so as to get holistic solution towards Air Pollution. Also, confused messaging with respect to performance indicators of Air Purifiers i.e. in build Air Quality monitors which are inefficient in capturing complete constituents of Air Pollution and can only provide mental satisfaction to users by providing inconsistent readings (only on PM 2.5 which constitute only 25 percent of Indoor Air Pollution) will see an end.

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