



Silent Air Purifier and Humidifier

¹Rajkumar Panchal*, ²Lakhan Mohan Pawar,

³Parag Rajendra Pawar, ⁴Anand Hanumant Urawane,

⁵Ritesh Tilokchand Patil

¹Head of Department Mechanical Engg, Parvatibai Genba Moze COE Wagholi, Pune

^{2,3,4,5} Department Mechanical Engg, Parvatibai Genba Moze COE Wagholi, Pune.

rajkumar.uvce@gmail.com

ABSTRACT

Air pollution has crossed all bounds in 2021. WHO estimates that around 7 million people die every year from exposure to polluted air. The spread of air pollution is so high that about 91% of the world population is exposed to air pollution.

Well, this also means that the air you breathe in your house is polluted. To counter this issue, we here develop a mini air purifier with that does not use expensive filters but rather uses water as an air filter. Also, it acts as an air humidifier and can be used as oil diffuser too which helps you relax and also kills certain bacteria and viruses present in the air.

The system makes use of 2 x high power low noise centrifugal fans that are used to suck in air through a protection mesh. The pulled air is then passed through a water tank situated at the bottom of the purifier. The air passed through water gets auto purified as water traps dust, fungi, bacteria etc in the water. The resulting air rising through the water is a high humidity cool air.

Also added essential oils to the system allow for humidifying the area/room with essential oils which are researched to kill certain types of bacteria fungi in air and help humans relax. Also, some essential oils are researched to provide various health benefits when inhaled.

Key words: Humidifier, Essential Oils, Bacteria, Fungi, Air Purifier

1.INTRODUCTION

Many countries and larger cities in the world are struggling with severe air pollution today. Factories, vehicles and use of non-renewable energy pollutes the air around the cities. In China and India this is a major problem, the polluted cities in these countries are home to more than 1 billion citizens. The solution that peoples use to clean the indoor air in the polluted areas are called air purifiers. (1) It is a device that most people that are affected by poor air quality keep in their homes and offices. The air purifier's function is usually to create an airflow in the home by suction from a fan inside the device. The air then passes through some sort of filter media which traps the polluted particles, and out comes clean air. However, most air purifiers on the market today are using a so-



called HEPA filter, which need replacement every few months and consume a lot of energy. This solution is rather costly and is not suitable for everyone, since one of the most important factors to customers when buying an air purifier is the price. An air purifier is also a part of the furnishings in a home, which also makes the aesthetic design of the air purifier important.

The most common problem during the summer season is pollution, dust, and allergies. With increase in the number of pollutants in the air, there is an increase in the demand for air purifiers. These air purifiers can be used in offices, homes, commercial places, and if their efficiency is high, then they can also be used outdoors. Air purifier is a device used to remove contaminants like dust particles, cloth fibers etc. present in the air. These devices are claimed to be beneficial to people having allergies, and asthma. 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 a heating ventilation and air-conditioning (HVAC) unit found in the medical, industrial, and commercial industries. Air purifiers may also be used in industry to remove impurities such as CO₂ from air before processing. A standard air purifier consists of various types of filters, and filter levels to remove the contaminants from the surrounding air.

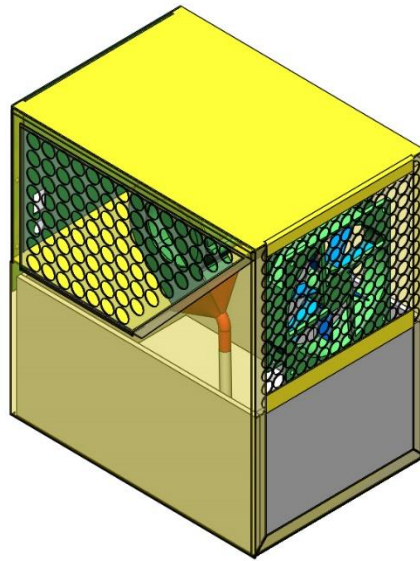
LITERATURE SURVEY

HEPA filters were originally classified as top-secret, developed by the US Atomic Energy Commission to protect soldiers from radioactive particles on the battlefield. During World War II, scientists involved in the Manhattan Project used HEPA masks to guard against contaminants from the atomic bomb. Although these early HEPA masks couldn't possibly protect people from atomic radiation, the research spawned the HEPA filter, which provided protection against chlorine gas, mustard gas, and flame throwers. It was not until the 1960s that specifications were standardized and the term HEPA or "High Efficiency Particulate Air" was officially coined by the Department of Energy (DOE). (2) As defined by the DOE, HEPA filters remove at least 99.97% of dust, pollen, mold, bacteria and any airborne particles with a size of 0.3 microns at 85 liters per minute. From the beginning, HEPA filters were employed to filter out highly hazardous aerosols, toxic cyanogen's, radioactive particles, and biohazardous contaminants. In Germany, brothers Klaus and Manfred Hammes purchased a patent for a simple air filtration system. Using a fiberglass pad attached with small magnets to the air outlet of a residential oil oven, the Hammes brothers were able to filter soot from the air. In 1963, the Hammes brothers simple but effective filter became the first air cleaner to be utilized in homes across Germany. In the same year, US Congress passed the Clean Air Act of 1963 to set standards for the reduction of air pollution through fuel emissions standards. Although it was not Congress first attempt at reducing air pollution, the Clean Air Act of 1963 alerted scientists and consumers of the need to protect our lungs from pollutants such as perfumes, building materials, chemicals, pesticides, and allergens.

2. DESIGN AND DEVELOPMENT

Several structural design considerations should be taken into account for economical and efficient manufacturing. Many of these apply to other joining methods, and all apply to both subassemblies and the complete structure.

- The device should be suitable for local manufacturing capabilities.
- The attachment should employ low-cost materials and manufacturing methods.
- It should be accessible and affordable by low-income groups, and should fulfill their basic need for mechanical power.
- It should be simple to manufacture, operate, maintain and repair.
- It should be as multi-purpose as possible, providing power for various agricultural implements and for small machines used in rural industry



IFig. 2.1 3D Model of Silent Air Purifier and Humidifier

Components

- Air Blower Pumps
- Water Tank
- Pipe
- Pipe Fittings
- Nozzle
- Pipe Connector
- Transformer/Adapter
- Protective Mesh
- Monitoring Glass
- Mounts and Joints
- Base Frame

- Supporting Frame
- Screws and Fittings

Fabrication Process

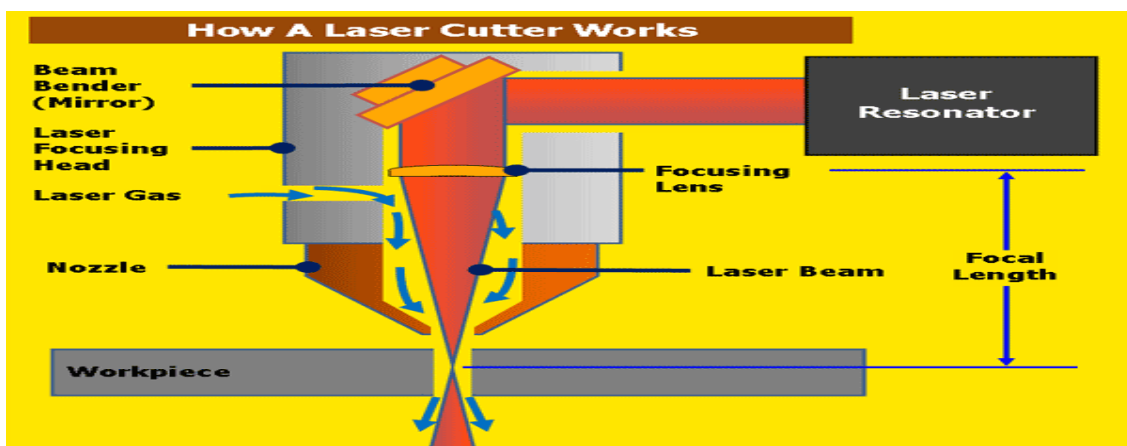
Metal fabrication is taking a raw material, typically sheets of metal and other flat materials, through a series of processes to create a finished end product. Virtually every industry relies on metal fabrication to operate efficiently, create the tools they need, develop products, etc. As you can see, it is a very broad industry that helps the entire world run.

fabrication is the process of manufacturing sheet metal and other flat materials to make them conform to specific shapes. The process starts with sheet metal around a quarter of an inch thick or less. At this thickness, the sheet metal and other flat materials is pliable enough to assume different shapes. Using this metal, fabricators alter the sheet to create a specific shape. This takes place through cutting, stamping, shaping, folding and welding. Another related practice is custom fabrication, meaning the creation of new custom parts using novel combinations of these processes.

Fabrication Process 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 CO2 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. (3) 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 K-Watts 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 all are controlled properly, laser cutting is a stable, reliable, and very accurate cutting process.

Laser Cutting



Laser cutting is mainly a thermal process in which a focused laser beam is used to melt material in a localized area. A co-axial gas jet is used to eject the molten material and create a kerf. A continuous cut



is produced by moving the laser beam or workpiece under CNC control. There are three major varieties of laser cutting: fusion cutting, flame cutting and remote cutting.

In fusion cutting, an inert gas (typically nitrogen) is used to expel molten material out of the kerf. Nitrogen gas does not exothermically react with the molten material and thus does not contribute to the energy input.

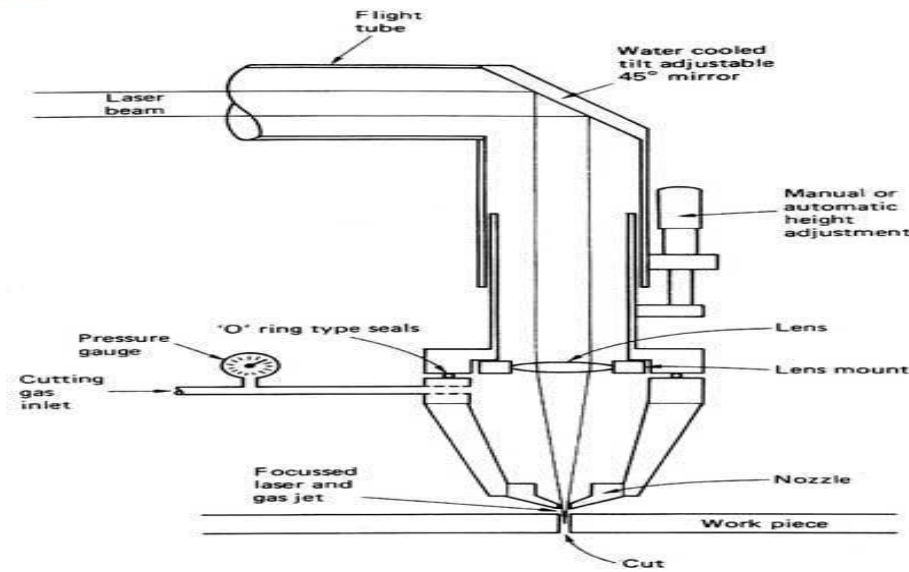
In flame cutting, oxygen is used as the assist gas. In addition to exerting mechanical force on the molten material, this creates an exothermic reaction which increases the energy input to the process.

In remote cutting, the material is partially evaporated (ablated) by a high-intensity laser beam, allowing thin sheets to be cut with no assist gas. The laser cutting process lends itself to automation with offline CAD/CAM systems controlling either three-axis flatbed systems or six-axis robots for three-dimensional laser cutting.

Improvements in accuracy, edge squareness and heat input control mean that the laser process is increasingly replacing other profiling cutting techniques, such as plasma and oxy-fuel. There are many states of the art laser machines on the market for cutting purposes, which can be used to cut metals, woods and engineered woods.

Cutting characteristics Benefits

- Cuts carbon manganese steels up to 20mm
- Cuts stainless steel up to 12mm
- Cuts aluminium up to 10mm
- Cuts brass and titanium
- Cuts thermoplastics, wood and many non-metals
- High quality cut – no finishing
- Ultra flexible – simple or complex parts
- Non-contact – no surface blemishing
- Quick set up – small batches
- Low heat input – small HAZ, low distortion Lends itself to nearly all materials



Types of Laser Cutting Used for Sheet Metal-

Nowadays most of industrial sheet metal laser cutting is carried out using two types of lasers: CO₂ and fibre.

CO₂ Laser

The CO₂ laser (carbon dioxide laser) is generated in a gas mixture, which mostly consists of carbon dioxide (CO₂), helium and nitrogen. Such a laser is electrically pumped using an electric discharge.

CO₂ lasers typically emit at a wavelength of 10.6µm. Those used for material processing can generate beams of many kilowatts in power. The wall-plug efficiency of CO₂ lasers is about 10%, which is higher than for most lamp-pumped solid-state lasers (eg ND:YAG lasers), but lower than for many diode-pumped lasers .

A CO₂ laser can cut thicker materials (>5mm) faster than a fibre laser of the same power. It also produces a smoother surface finish when cutting thicker materials.

Laser cutting of sheet metals historically started with CO₂ lasers. Most CO₂ laser cutting machines are three-axis systems (X-Y, two-dimensional positioning control with a Z-axis height control).

There are, however, a number of ways of achieving the X-Y movement: either moving the laser head, moving the workpiece or a combination of both.

The most popular approach is known as a 'flying optics' system, where the workpiece remains stationary and mirrors are moved in both X and Y axes. The advantages of this approach are that the motors are always moving a known, fixed mass. This can often be much heavier than the workpiece, but it is easier to predict and control.

As the workpiece is not moved, this also means that there is no real limit to sheet weight. The disadvantage of flying optics is the variation in beam size, as a laser beam is never perfectly parallel, but actually diverges slightly as it leaves the laser.



This means that without controlling the divergence, there may be some variation in cutting performance between different parts of the table, due to a change in raw beam size. This effect can be reduced by adding a re-collimating optic, or some systems even use adaptive mirror control.

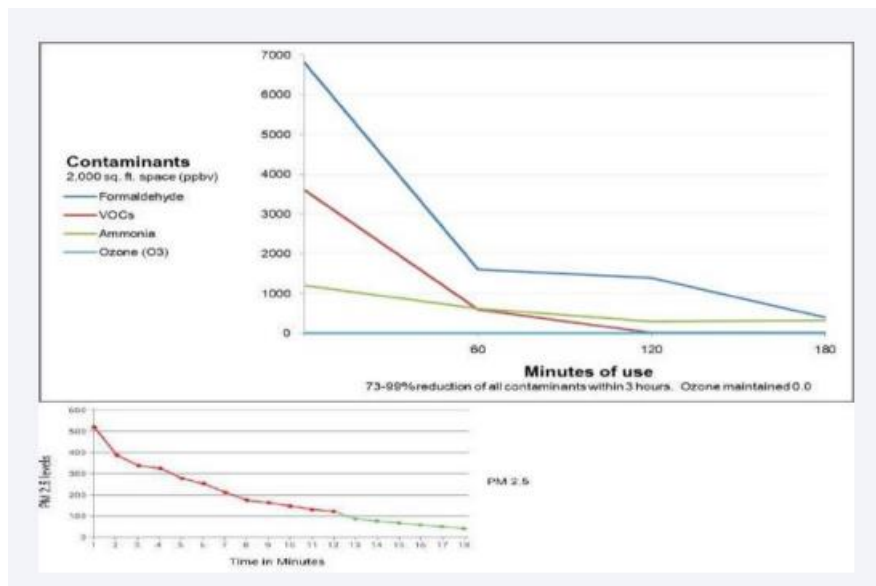
The alternative is a 'fixed optic' system where the laser head remains stationary and the workpiece is moved in both X and Y axes. This is the ideal situation optically, but the worse situation mechanically, especially for heavier sheets.

For relatively light sheet weights, a fixed optic system can be a viable option, but as the sheet weight increases, accurately positioning the material at high speed can be a problem.

The third option is known as a 'hybrid' system, where the laser head is moved in one axis and the material moved in the other axis. This is often an improvement over fixed optics, but still suffers from difficulties with heavier sheet weights.

3. 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 fibres, the micro particles and microorganisms like bacteria, and fungus up to a level of 0.3 microns will be stopped with a 99.97%.



4. CALCULATIONS

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.

$$\text{Smoke CADR value} = \text{Square Feet of Room} / 1.55$$

$$\text{Square feet of room} = 275 \text{ sq. ft}$$



Smoke CADR value = $275 / 1.55 =$
 $177.19 \text{ m}^3/\text{hr}.$

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. (4) As you would have already figured out by now, it is one of the most important factors that signifies the effectiveness of the air purifier.

$\text{CADR} = 177.19 \text{ m}^3/\text{hr}.$ CADR in cubic feet per minute = $300 \times 0.588 = 104.19 \text{ cfm}$ Air changed in an hour = $104.19 \times 60 = 6251.4$ (CADR in CFM x number of minutes in an hour) Room volume = 2475 (275×9), as

Room height is assumed to be 9 ft.

$\text{ACH rating} = \text{Air changed in an hour} / \text{Room Volume}$

$\text{ACH rating} = 6251.4 / 2475 = 2.5$

5. RESULTS

Successfully we achieved the result of “Silent Air Purifier & Humidifier” to counter the breathing issue due to polluted air, we here develop a mini air purifier with that does not use expensive filters but rather uses water as an air filter.

- 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: 175m³/h
- Air Change per Hour: 2.56
- Time required to purify air to a safe level: 10-15min

6. 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. (5) 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. (6) 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

7. 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. (7) 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. (8) 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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