

# AIR PURIFICATION SYSTEM FOR METRO CITIES

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**ABSTRACT** - Pollution in many forms such as air pollution, water pollution and land pollution are the major contributors for the spread of disease throughout the globe. The rapid development of industries and technologies have increased the amount of pollutants in the environment. Stringent pollution norms are developed and incorporated in developing and developed countries alike in order to reduce the pollution. However it has not successfully controlled the amount of pollution because of increase in the number of automobiles, industries and construction activities. In this paper, methodology to control air pollution has been discussed. A novel technique has been developed to effectively absorb the suspended particulate matters and harmful gases in the air. The developed device could make use of renewable forms of energy like sunlight and wind for its operation. The device can be easily constructed and installed in outdoor places with high contamination in the air. It can convert heavily polluted air into particulate free air. The success of the operation of this device could become a boon for every living being near the industries and metro cities.

**Keywords:** Air pollution, renewable energy, novel technique, metro cities.

## 1. INTRODUCTION

The rapid increase in global population, rapid development and industrialization around the world, increase in automobiles and deforestation activities have resulted in contaminating land, water and air the around the globe [1, 2]. The challenges faced to meet pollution in our country have been increasing day by day.

Many steps are taken by our government to keep the pollution levels in our country in check. These includes: stringent pollution norms for automobiles, providing free LPG gas to rural areas, enforcing laws to incorporate pollution controls in industries, ban on tobacco products are few of the examples [3-6]. Besides these control measures, the number of deaths related to pollution is increasing in a daily basis.

Air pollution is one of the worst forms of pollutions because of its tendency to cause breathing problems and suffocation leading to quick death compared to other forms of pollutions [7].

This paper highlights the current norms and standards followed in our country to control air pollutions. The existing methods available to remove suspended particles, mixed gases and pathogens in the air are intimated. This paper can be used as a reference to understand the technologies to develop a good device capable to purifying air.

## 2. EXISTING POLLUTION NORMS

Air pollution is important factor which affects human health and has become an issue of global concern. The most recent update on air pollution by the World Health Organization WHO gave a stunning result It was estimated that during the past two years, the air pollution measured in 3000 cities from 103 countries around the globe have doubled. In urban areas, air pollution is major cause for health issues such as stroke, heart disease, lung cancer, chronic / acute respiratory diseases and asthma as shown in Fig. 1. The figure also shows the extent of air pollutions in various regions around the globe. It can be found that our country which exists in South East Asia stands second among the most polluted around the world.

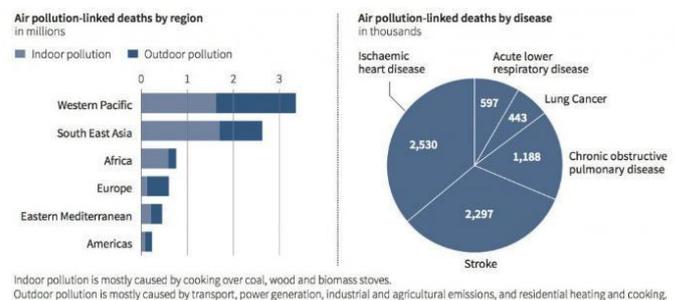


Fig. 1 Global air pollution and associated deaths [9]

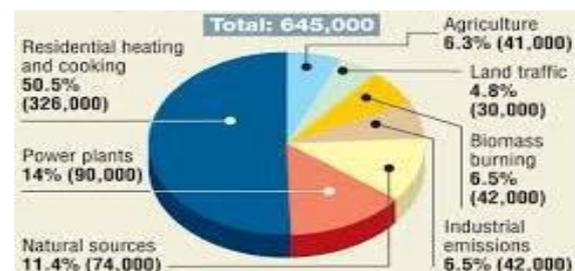


Fig. 2 Estimated premature deaths due to outdoor pollution in India [10]

Fig. 2 shows the comparison between outdoor pollutions and the related deaths in our country during 2012. It was found that more than 50% of deaths related to outdoor pollution resulted from the smokes occurring due to cooking and building heating. The next highest mortal rate of 14% was found to be originated because of air pollution from power plants. A total of 645000 deaths were reported every year solely because of outdoor pollution.

Fig. 3 shows the contributions of various classes of automobiles on the air pollution in India. Majority of air pollution occurred because of three wheelers, heavy duty trucks, buses and light motor vehicles. These vehicles are ever increasing in our country as part of its development and purchase by individuals every year.

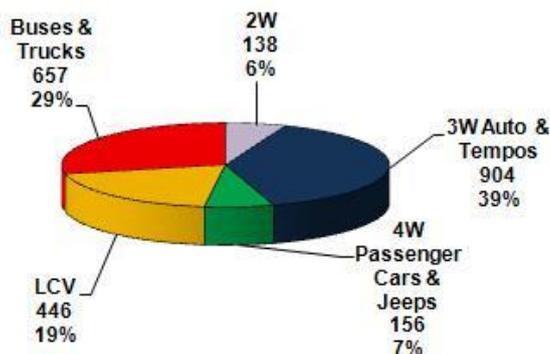


Fig. 3 Contributions of various vehicles to air pollution [11]

### 3. MEASURES TO CONTROL AIR POLLUTION IN INDIA

Ambient air pollution has become a cause for alarm in India in particular because recent data suggest that ambient pollution levels in Indian cities are some of the highest in the world. In fact, globally, 13 of the 20 cities with the highest mean levels of PM<sub>2.5</sub> –which refers to particles with a diameter less than or equal to 2.5µm–are in India, and Delhi ranks as the worst [12].

It is a necessity that control measures have to be taken and implemented in order to reduce the threats possessed by the air pollution. Our government is already imposing pollution norms and pollution laws. Some of the steps are:

1. Implementing BSIV regulations for vehicles
2. Odd and even numbers registered vehicles to operate on alternative days in our capital

3. Subsidies for cooking gas connections
4. CNG auto rickshaws and buses are given clearance to operate in metro cities.
5. E-rickshaws implemented in and around our national capital.
6. Alternate day power cut and gas connection cut in some states
7. Compulsory implementation of pollution regulators and pollution control devices in industries

Metro cities and regions surrounding industries and power plants are the most pollution affected places around the globe. There are many methods that exist today to control air pollution. The major contributors of air pollution are: Oxides of Sulphur (SO<sub>x</sub>), Oxides of Carbon (CO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>) and particulate matters. The pollution norms implemented on automobiles in our country are shown in Table 1.

It can be seen that the rate of pollutants permitted decreases. This is to enable the reduction in pollutants mixing with our breathable air. In spite of these steps, the pollution level is increasing day-by-day. Hence there is a need for an effective way to trap the suspended particulates in the polluted air. This will ensure clean air which is free of dirt and suspended particles.

Table 1. Bharat norms

Year	Reference	CO	HC	HC +N	NO <sub>x</sub>	PM
1992	-	17.3	2.7	-	-	-
		-	3.7			
		32.6				
1996	-	5.0	-		-	-
		9.0				
				0 <sub>x</sub>		
2000	India 2000	-	-	-	-	-
		1.90		1.70	0.25	
2005	BS II	1.0-1.5	-	0.7-1.2	0.08-0.17	-
2010	BS III	0.44-0.95	-	0.56-0.86	0.50-0.78	0.05-0.10
2010	BS IV	0.50-0.74	-	0.30-0.46	0.25-0.39	0.025-0.06

#### 4. EXISTING METHODS TO CONTROL AIR POLLUTANTS

##### 4.1. High Efficiency Particulate Air method [HEPA]

High Efficiency Particulate Air (HEPA) uses fine filters made using organic materials like cotton and also inorganic materials such as nylon. The fine size of the filters can trap 99.97% of particulates which are as small as 0.3 μm. However the filters cannot remove nano sized particles, bacteria and virus from the contaminated air. The mixed gases such as CO<sub>2</sub>, SO<sub>x</sub> and NO<sub>x</sub> cannot be removed from the air, which makes it an obsolete technique. Additionally the trapped particulates can act as a breeding ground to microorganisms which will lead to mould and foul odour if the filters are not cleaned periodically.

##### 4.2 Ozone Air Purifier

Ozone air purifiers makes use of ozone gas (O<sub>3</sub>) for removing unwanted gases such as CO<sub>2</sub>, SO<sub>x</sub> and NO<sub>x</sub> in the air. Because of the good properties of the O<sub>3</sub> gas like non-poisonous, non-polluting, non-flammable there is wide scale acceptance by the general public and by the government alike. These gases are effective in controlling indoor air pollution. However health experts claims that continuous exposure to O<sub>3</sub> gases may lead to long time health hazards like asthma and lung infection. These claims and the difficulty in manufacturing these gases have resulted in non-availability of the gases for commercial use. Ozone cannot remove particulates and microorganisms from the Air.

##### 4.3 Activated carbon

Activated carbon have been used for cleaning contaminated water for the past 2000 years. However its application for purifying air was discovered recently. During World War I, granular activated carbon particulates were incorporated in gas masks. This enabled the soldiers to breathe normally in air polluted with particulates and poisonous gases as shown in Fig.4



Fig.4 Gas mask used by German soldiers during World War I [13]

Activated carbon air filters consist of a vast system of pores of molecular size. These pores are highly adsorbent, forming a strong chemical bond/attraction to odorous, gaseous, and liquid contaminates, especially organic chemicals/compounds

##### Activated Carbon Filter Facts and Studies

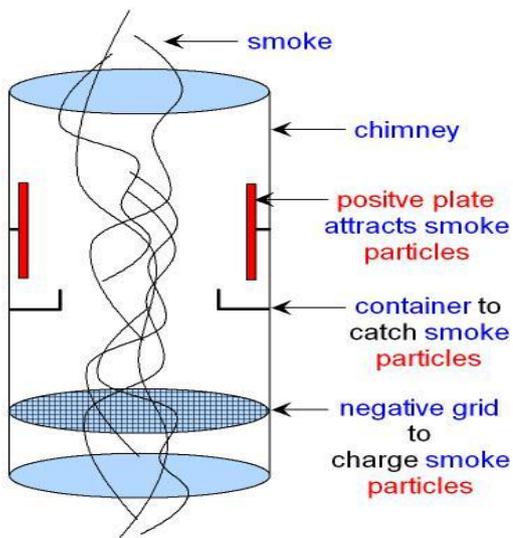
- [1] Activated carbon air filters trap odours and chemicals in highly absorbent granules (or pores), which look like a hard scrub brush.
- [2] Activated carbon is a charcoal that is treated with oxygen in order to open up millions of tiny pores between the carbon atoms, resulting in a highly adsorbent material.
- [3] Originally used in World War II to protect U.S. soldiers from chemical warfare agents.
- [4] In a study commissioned by the **U.S. Dept. of Energy**, activated carbon filters were found to remove 60-70% of airborne ozone compared to filters without activated carbon.
- [5] Another study commissioned by the **U.S. Dept. of Energy** found that activated carbon filters removed Harmful
- [6] VOC's (Volatile Organic Compounds) by 60-80%, and formaldehyde by 25-30%.

According to a report released by the **Centres of Disease Control, Dept. of Health and Human Services**, and the **National Institute for Occupational Safety and Health**, activated carbon is an excellent adsorbent/adsorber of most organic chemicals.

##### 4.4 Electrostatic charge filters

The electrostatic charge filters make use of electrostatic charge to attract the charged particulates in the polluted air. These filters are mostly installed in chimneys where flue gas from industrial process are left to the atmosphere. Fig.5 shows the sketch of an electrostatic filter.

The chimney in the industries are provided with high voltage positive grid, while the particles retain negative charge. The particles get attracted to the positive charge and get deposited in the grid. Upon considerable period of operation, the particulates get agglomerated and form a lump of mass in the grid, which can be cleaned periodically. This method is economical in highly polluted places, however it requires lot of electricity for its operation. The bulky size of this filters make it unsuitable for installing indoors



5Electrostatic filter [14]

remove some of this pollution. This artificial mushroom houses four directional LED street lights and an Air Purification System (APS). Four intakes suck in polluted air and pass it through the APS, positioned centrally within the structure. The purified air is finally released through the annular vent on the air duct built around the light pole. A network of Eco Mushrooms integrated into the existing roads could help curb automotive pollution effectively while allowing for smart integration that can send information to a central hub about pollution trends and maintenance needs

This system will be total eco-friendly as there will be no use of external electric supply as it will work on its own power developed by the photovoltaic panels and turbines installed in them. There is use of led lights which will provide sufficient lights during night time. This setup can be installed as the street light has been installed on streets. But the main advantage over the street lights will be that it will not only provide lights during night time but also keep the pollution level low in the particular area.

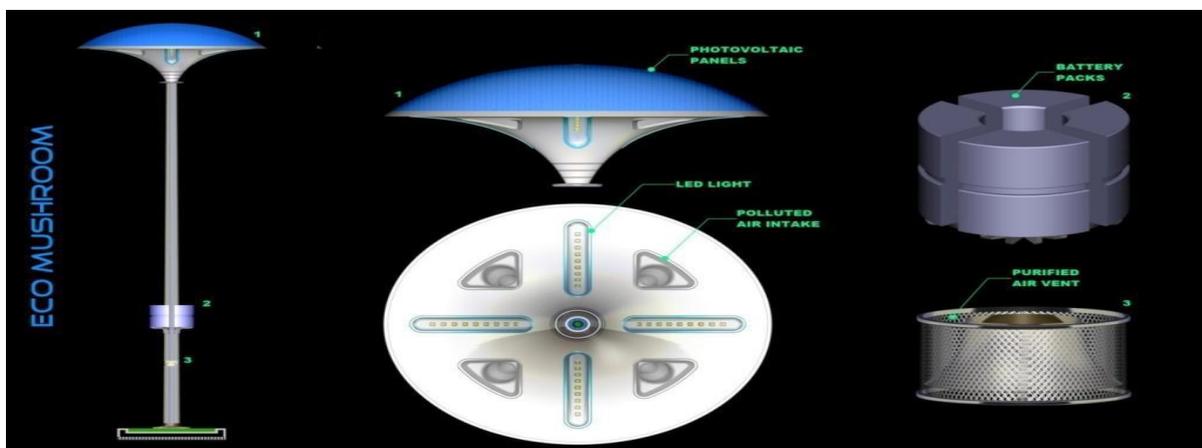
#### 4.5 Eco Mushroom

The Eco Mushroom is a new arrival for air filters. The design of these filters are simple and can be easily installed along the payments in roads where high quantity of particulates get emitted from automobile exhaust. Metro cities can be an ideal place for installing these filters.

The following setup includes the following as shown in Fig.6.

1. photovoltaic panel, turbine
2. battery packs
3. purified air vent
4. led lights

The 'Eco Mushroom' is a compact design for a solar powered street light equipped with CO<sub>2</sub> scrubber to help



## 5. CONCLUSION

1. There is incremental increase in the level of air pollution around the globe
2. Stringent pollution norms and environmental laws have done little to reduce the intake of pollution in air
3. Developing countries and developed nations suffers the impact of air pollution
4. This paper provides information in existing and new techniques for controlling air pollution
5. This paper can be used as a base for developing ideas to design a device which can effectively control and minimise air pollution in metro cities.

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