

# **Automobile Air pollution in Hyderabad City, Andhra Pradesh, India during the year 2009**

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**ABSTRACT:** Automobile air pollution is a growing problem in Hyderabad, Andhra Pradesh, India and as such it needs immediate attention before it goes out of control. The problem is most pronounced in the city centre especially during rush hours. This paper starts by citing some environmental effects of air pollution. It then analyses the problem of automobile air pollution in Hyderabad. It also goes on to show that vehicles in Hyderabad whose number is increasing at the rate of 6% annually contribute to the problem. Furthermore, the paper reveals that one of the main reasons for the air pollution problem in the city centre is large traffic volume which is concentrated on just 4% of the total road length in the city. Another reason identified in this paper is the increase in number and density of high rise buildings, which end up hindering pollutant dilution by natural ventilation. A shortage of parking places also contributes to the problem. This paper further reveals that automobile exhaust gas coefficients for nitrogen oxides and carbon monoxide are high. This is mainly attributed to low-energy efficiency of engines of most of the cars plying city roads due to old age. Concentrations of nitrogen oxides and carbon monoxide in the exhaust gas are also found to be high. Finally, this paper forwards legal and administrative as well as technical measures to arrest the problem. Enacting and enforcing of special laws pertaining to control and prevention of air pollution are also emphasized along with other measures.

**KEYWORDS:** Air pollution; Road traffic; Exhaust gases; Automobile; Hyderabad

## **I. INTRODUCTION**

Industrial activities and transport systems are the world's most serious causes of air pollution, and findings on both fairly well documented in developed countries. Air pollution can be defined as 'the change of composition of air by the addition of harmful substances like the industrial and automobile gases and particulate matter'. Most of the sources of air pollution are related to man's activities as a result of the modern lifestyle. Added to this are also natural causes like the volcanoes, anaerobic decomposition of organic matter, atmospheric reactions, etc. The major problem that the atmosphere is being subjected to is pollution. In India, about 100 million tons of pollutants are being added to the atmosphere annually. This figure is likely to go up in future. Polluted air is harmful to man and the biosphere on the whole, as well. This problem needs to be tackled urgently. Since all of us contribute to it directly or indirectly, we must study air pollution in detail and discuss the means of controlling and preventing it. Attempts to redress the situation, though isolated and uncoordinated, are evident. To that end, various studies have looked at air pollution, mainly as part of other projects, and to a limited extent as studies in their own right. As a result, a few incidents of air pollution from industrial sources, and an even smaller number of transport-related air pollution incidents have been reported. The department of Andhra Pradesh Pollution Control Board (APPCB) and Central Pollution Control Board (CPCB), Ministry of Environment and Forest, Govt. of India and other Institutions have conducted a number of studies on air pollution pertaining to both industrial and vehicular traffic sources. This paper is an attempt to contribute to consideration of traffic-caused air pollution in Hyderabad, Andhra Pradesh, India. It looks at air pollution in the backdrop of the traffic situation in the City of Hyderabad, then it examines the associated problems, and subsequently it recommends some remedial measures.

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## II. SOURCES OF AIR POLLUTION

The air pollution is due to activities of human beings and also natural causes like the volcanoes, anaerobic decomposition of organic matter, atmospheric reactions, etc. The main sources of air pollution are burning of fossil fuels, automobiles, industries, fertilizer plants, thermal plants, textile industries and steel plants etc. Fossil fuels include petroleum and coal and burning of coal produces a lot of smoke and dust whereas burning of petrol mainly produces sulphur dioxide. In addition to these, the pollutants include carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), nitrogen oxides, hydrocarbons, particulate matter and traces of metals. In automobile combustion of petrol or diesel produces carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO<sub>x</sub>), aldehydes, sulphur compounds (SO<sub>x</sub>), organic acids and ammonia and carbon particles. The fertilizer industries produce hydrocarbons (HC), nitrogen oxides (NO<sub>x</sub>), sulphur compounds (SO<sub>x</sub>), particulate matter and fluorine, thermal plants produce fly ash, soot and sulphur dioxide (SO<sub>2</sub>), textile industries produces cotton dust, nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), chlorine, naphtha vapors and smoke, steel plants produce carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), sulphur dioxide (SO<sub>2</sub>), phenol, fluorine, cyanide and particulate matter, etc<sup>1-2</sup>.

Major Air Pollutants: The main categories of air pollutants are<sup>5-6</sup>:

Oxides of Carbon: The main sources of carbon monoxide and carbon dioxide are automobile exhaust, photochemical reactions in the atmosphere, biological oxidation by marine organisms, carbon burning of fossil fuels and depletion of forests, etc

Sulphur Dioxide: A general term for oxides of sulphur, which are emitted from motor vehicles burning fuel containing a high concentration of sulphur and the main sources of sulphur dioxide are automobile exhaust, industries, burning of fossil fuels, forest fires, electric generation plants, smelting plants, industrial boilers, petroleum refineries and volcanic eruptions, etc.

Oxides of Nitrogen: The main sources of oxides of Nitrogen are automobile exhausts, burning of fossil fuels, forest fires, electric generation plants, smelting plants, industrial boilers, petroleum refineries and volcanic eruptions, etc. These are generated when nitrogen in the air reacts with oxygen at the high temperature and pressure inside the engine. NO<sub>x</sub> is a precursor to smog and acid rain. NO<sub>x</sub> is a mixture of NO and NO<sub>2</sub>

Hydrocarbons: The main sources of Hydrocarbons are unburned or partially burned or incomplete combustion of fuel in automobiles, industries, leaking fuel tanks, leaching from toxic waste dumping sites and coal tar lining of some water supply pipes, etc.

Organic and inorganic Particulate matter: Soot or smoke made up of particles in the micrometre size range. The main sources of particulate matter are photochemical reactions of hydrocarbons and nitrogen oxides, combustion of leaded gasoline products, mining activities, stone cutting, pottery, glass manufacturing, cement industries, flowers and microbes, etc.

Among all these the major pollutants from motor vehicles exhaust are Hydrocarbons, Carbon monoxide (CO), Carbon dioxide (CO<sub>2</sub>), Nitrogen oxides (NO<sub>x</sub>), Sulphur oxides (SO<sub>x</sub>) and particulate matter.

## III. EFFECTS OF AIR POLLUTION

### GLOBAL WARMING

The global temperature is increasing due to increasing in pollution levels and levels of the green house gases such as water vapour, methane, chlorofluorocarbons (CFCs) and nitrous oxide, etc, called as 'Global warming'. Greenhouses are glass houses, which maintain a temperature higher than the surroundings for the plants to grow and yield better. Most of the solar radiation entering the earth's atmosphere is reflected back into the space. However, the gases like

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carbon dioxide absorb some of the heat. This serves to keep the earth warm much like the greenhouses. The global warming effects the climate, disturbance of plants, animals, agriculture and food production, increases sea levels by melting of snowcaps causes submerging of coastal areas.

## PHOTOCHEMICAL SMOG

Smog is derived from the words Smoke and fog; this is formed due to photochemical reaction of pollutants like hydrocarbons and nitrogen oxides combines in the presence of sunlight. It forms a yellowish brown haze especially during winter and hampers visibility also causes many respiratory disorders and allergies as it contains polluting gases.

## ACID RAIN

Sulphuric acid ( $H_2SO_4$ ) and nitric acid ( $HNO_3$ ) are produced when Sulphur dioxide ( $SO_2$ ) and nitrogen oxides ( $NO_x$ ) react with water in the atmosphere and these acids come down along with the rain, this phenomenon is called as acid rain. The pH of acid rain varies from 3-6. This acid rain causes respiratory and skin disorders, reduces productivity of plants by damaging the leaves, harm to the aquatics, damage to marbles and thus damage to buildings and monuments.

## AEROSOL

Dispersion of solid or liquid matter in the atmosphere forms aerosol. The pollutant particulate matter like carbon particles forms pollutant aerosol. It forms a thick layer in the troposphere, which affect the weather conditions by blocking the solar radiation. Aerosols are also deposited on the leaves and affect the photosynthesis. Aerosols disperse the organic metallic pollutants far and wide.

## OZONE DEPLETION:

The stratosphere of the atmosphere has ozone ( $O_3$ ). Ozone protects us from the harmful effects of the UV rays by absorbing the ultraviolet (UV) rays present in the sun's radiation. However, the pollutants, hydrocarbons such as the chlorofluorocarbons (CFCs) destroy the ozone molecules, which deplete the ozone layer. Ozone holes have been detected in the atmosphere, which permit the UV rays to reach the earth's surface. The harmful effects of the UV rays are visible in the countries such as Australia and New Zealand where the rate of skin cancer is higher than the other regions of the world.

## IV. EFFECTS OF THE AUTOMOBILE EXHAUST POLLUTANTS

The effects of automobile exhaust pollutants on vegetation; animals and human beings are as follows.

**Oxides of Carbon:** CO combines with haemoglobin, thus reduces the oxygen-carrying capacity of blood, which affects the respiratory activity. Also results in blurred vision, headache, unconsciousness and death due to asphyxiation.

**Sulphur Dioxide:** It causes respiratory problems, severe headache, reduced productivity of plants, yellowing and reduced storage time for paper, yellowing and damage to limestone, marbles and leather, increased rate of corrosion of iron, steel, zinc and aluminium.

**Oxides of Nitrogen:** It affects the photosynthetic activities of plants and causes respiratory problems in mammals.

**Hydrocarbons:** It causes carcinogenic/leukemia and destroys ozone layer, which then permits harmful UV rays to enter the atmosphere, irritation of eye, throat and respiratory tract, damage to clothes, paint and rubber articles, damage to leaves and stomatal tissue in plants.

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Organic and inorganic Particulate matter: It causes toxic effect in man, asbestosis, and cancerous disease of the lungs silicosis, allergy and infection disease

## V. RATIONALE FOR CONCERN ON AIR POLLUTION

Despite the general feeling that environmental impacts of air pollution are generally known and well publicised, it is indisputably true that there is still a need to educate the public on effects, which have a direct bearing on their health and socioeconomic welfare. In this regard, the most important environmental impacts include: effects on human health, effects on animal health, effects on vegetation and effects on materials and other things of socio-economic value.

Effects on human health are manifested as respiratory diseases such as bronchitis whose correlation with air pollution is well established and documented<sup>1-6</sup>. Also, health effects of specific pollutants from both industrial and vehicle emissions are known. Lead poisoning, which is from leaded petrol, is known to lead to kidney cancer and retardation of the central nervous system. Lead also affects both haemoglobin synthesis and red blood cells' survival times in the body. The World Bank has described lead as 'the greatest environmental threat to many cities in the developing world'. Inhalation of carbon monoxide (CO), which is also found in vehicle emissions, ends up putting a strain on the heart and impairing coordination. Nitrogen dioxide (NO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>), all of which are gases emitted with fuel combustion products, have been shown to be closely associated with occurrence of diseases such as pharyngitis, bronchitis, tonsillitis, colds, and sore throat. Air borne particulates like ash, soot, dust and smoke, which result from erosion of soil and spoil tips as well as from industrial, domestic and traffic sources, cause health hazards. The mucous epithelium, in man, traps much of the particulate matter but smaller particles can penetrate deep into the lung itself. Worse still, particulate dispersal helps to transport heavy metals. Lead, cadmium and zinc have been shown to be deposited on leaves of plants in this way.

Effects on animal health upon inhalation of harmful gases and grazing contaminated grass are similar to those on man. It can be noted that concentrations of pollutants on grass that is eaten by animals may end up not only killing or harming the animal, but also passing the pollutants on to man, if the animals are eaten - as is usually the case. Acidification and adsorption of carbon dioxide (CO<sub>2</sub>) affects vegetation through alteration in insulation pattern and blocking of stomata on plant surfaces with the end result being stunted growth or death, both of which lead to economic losses. Corrosion, colour change and damage to surfaces, as well as undue expansion, blistering, and scaling are possible effects on materials, which are exposed to air pollution. Loss of visibility, which can also cause traffic disruption and accidents, is another effect of air pollution.

## VI. AIR POLLUTION AND THE ROAD TRAFFIC SITUATION IN HYDERABAD

Industries have a potential for a significant contribution to air pollution in Hyderabad, Andhra Pradesh, India in future. Comparatively, the present level, distribution and pace of industrialization, do not give credence to immediate concern. Air pollution caused by traffic is, on the other hand, considered worthy of coverage because of recent increases in road traffic volume whereby more than 80 000 automobiles are put on the road every year in Hyderabad, Andhra Pradesh, India. More over, the proportionate increase in importation of used and recycled vehicles into Hyderabad; Andhra Pradesh, India is a strong enough basis for concern on traffic-caused air pollution. Of all urban centres in Hyderabad, Andhra Pradesh, India has the greatest potential for being adversely affected by traffic-caused air pollution. Hyderabad is the capital city of Andhra Pradesh and the fifth largest city in India. The city located at 17° 26' 58" of the Northern Longitude and 78° 28' 34" of the Eastern Longitude. The aerial extent of Greater Hyderabad district extends over 650 sq km. According to 2001 Census, the total population of the District is 35,75,064 about 54.20% of which live in the urban area. There are 497 large and medium scale industries in addition to 23642 small scale Industries in the District. The major sources of employment are government, public sector, trade & commerce, industries, agriculture, horticulture and animal husbandry, which engage almost 80% of the workforce. The major industries are that of chemicals, pharmaceuticals, oil, cotton, tools, lead batteries, food processing, pharmaceuticals, asbestos, foam, coir and stone crushing.

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The potential for traffic-caused air pollution in Hyderabad is due to its being home to the largest proportion of all vehicles imported into Hyderabad, Andhra Pradesh, India, notwithstanding the lack of specific data to support the assertion. Another reason is the increase in number as well as height of high rise buildings and crowding of buildings and population. This is significant because height and density of buildings influence the pattern of pollution dispersion.

The number of registered vehicles in Andhra Pradesh, India was estimated and projected as shown in Table 1 and figure 1.

**Table 1. Estimates and projections of registered vehicles in Andhra Pradesh, India**

Category of Vehicle	No. of Vehicles in Lakhs
2 Wheelers	55.1862
3 Wheelers	4.39787
LMV	9.48719
MMV	1.26498
HMV	2.47992
Others	3.9666
Total	76.78276

(Source: Andhra Pradesh Road Transport Authority, Hyderabad)

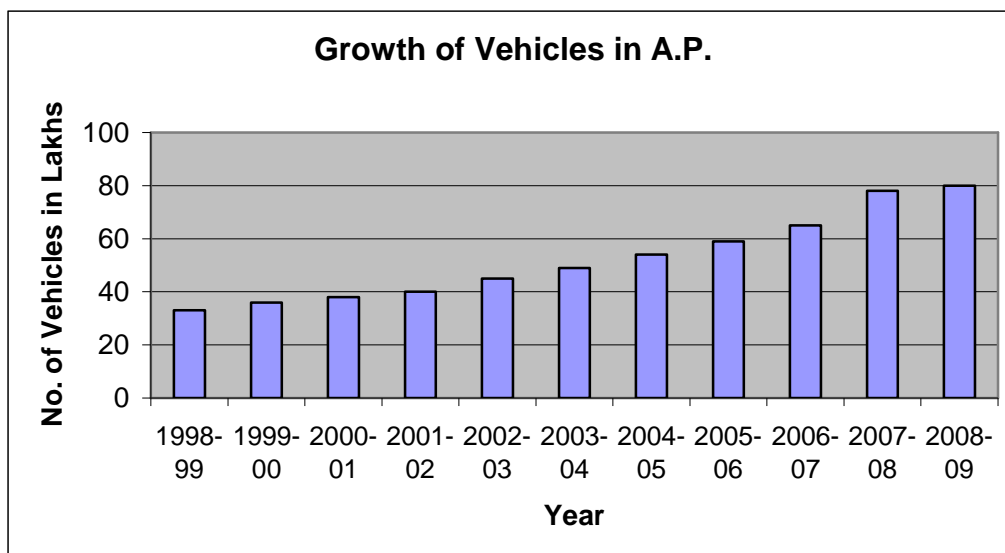


Fig. 1 Growth of Vehicles in Andhra Pradesh, India (Source: Andhra Pradesh Road Transport Authority, Hyderabad)

At an annual increase of 6% the number of vehicles registered in Andhra Pradesh, India in 2009 has been projected to be 80 lakhs of which almost 60% will be passenger cars and 15% will be two wheelers. The too high increase in the number of motor vehicles, as is the case now in Hyderabad is a sure pointer to potential air pollution. On the other hand, the present road network system in Hyderabad adds up. It has also been noted that 75% of all passenger cars are found on roads located in the city centre. This adds to the air pollution problem because of the concentration of many emission sources in the city centre, apart from the many and closely spaced tall buildings, which have a tendency to hinder dispersion of pollutants. Peak hours of traffic, which have been determined to range between 07.00 and 10.00 h,

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and between 15.00 and 19.00 h in the morning and evening, respectively; follow the pattern of movement of workers to and from work.

Since most people work in or near the city centre where most work places are, the potential increase in use of vehicles will tend to concentrate vehicle emission in the city centre and along the major roads. In addition to that, the fact that more than 500000 people per day use buses in the city centre, means an equal number of people are exposed to air pollution effects associated with traffic causes in the city centre. This situation is made worse by the fact that while there are just about 5000 authorized parking places, the number of vehicles normally found parked in the city centre is well over 150 000 per day. This implies that these vehicles are a cause of traffic congestion and unnecessary localized traffic movements, which are borne out of looking for parking places. Both traffic congestion and the localised movements lead to burning of more fuel, and hence increase the potential for air pollution.

### VII. AUTOMOBILE EXHAUST GASES

Findings on air pollution from automobile exhaust gases in Hyderabad have been reported basing on surveys carried out in different parts of the city. A study carried out by the Andhra Pradesh Pollution Control Board (APPCB), Andhra Pradesh, Hyderabad on exhaust gas component concentrations, among other parameters. The concentrations of air pollutants for different motor vehicle running conditions and the National Ambient Air Quality standards as per Central Pollution Control Board (CPCB), Ministry of Environment and Forest, Govt. of India are shown in Table 2 & 3.

**Table 2. Concentrations of air pollutants for different motor vehicle running conditions**

Norms	2/3 Wheelers		Passenger Cars		Heavy Diesel Vehicles			
	CO (g/km)	(HC + NO <sub>x</sub> ) (g/km)	CO (g/km)	(HC + NO <sub>x</sub> ) (g/km)	CO (g/kmhr)	HC (g/kmhr)	NO <sub>x</sub> (g/kmhr)	PM (g/kmhr)
1991 Norms	12-30	8-12 (HC only)	14.3 – 27.1	2.0 (HC only)	14	3.5	18	
1996 Norms	4.5	3.6	8.68 – 12.40	3.0 – 4.36	11.2	2.4	14.4	
1998 Norms			4.34 – 6.2	1.5 – 2.18				
India Stage 2000 Norms	2.0	2.0	2.72	0.97	4.5	1.1	8.0	0.36
Bharath Stage II	1.6	1.5	2.2	0.5	4.0	1.1	7.0	0.15
Bharath Stage III	1.0	1.0	2.3	0.35 (combined)	2.1	1.6	5.0	0.10
Bharath Stage IV			1.0	0.18 (combined)	1.5	0.96	3.5	0.02

Source: Central Pollution Control Board, Ministry of Environment and Forest, Govt. of India.

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**Table 3. Ambient Air Quality Standards**

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive area (Notified by Central Govt.)
1	Sulphur Dioxide (SO <sub>2</sub> ), µg/m <sup>3</sup>	Annual*	50	20
		24 hours**	80	80
2	Nitrogen Dioxide (NO <sub>2</sub> ), µg/m <sup>3</sup>	Annual*	40	30
		24 hours**	80	80
3	Particulate Matter (size less than 10 µm) or PM <sub>10</sub> µg/m <sup>3</sup>	Annual*	60	60
		24 hours**	100	100
4	Particulate Matter (size less than 2.5 microns) or PM <sub>2.5</sub> µg/m <sup>3</sup>	Annual*	40	40
		24 hours**	60	60
5	Ozone (O <sub>3</sub> ) µg/m <sup>3</sup>	Annual*	100	100
		24 hours**	180	180
6	Lead (Pb) µg/m <sup>3</sup>	Annual*	0.5	0.5
		24 hours**	1.0	1.0
7	Carbon Monoxide (CO) mg/m <sup>3</sup>	Annual*	2	2
		24 hours**	4	4
8	Ammonia (NH <sub>3</sub> ) µg/m <sup>3</sup>	Annual*	100	100
		24 hours**	400	400
9	Benzene (C <sub>6</sub> H <sub>6</sub> ) µg/m <sup>3</sup>	Annual*	5	5
10	Benzo (a) Pyrene (BaP) –particulate phase only ng/m <sup>3</sup>	Annual*	1	1
11	Arsenic (As) ng/m <sup>3</sup>	Annual*	6	6
12	Nickel (Ni) ng/m <sup>3</sup>	Annual*	20	20

Source: Central Pollution Control Board, Ministry of Environment and Forest, Govt. of India.

The main purpose of the study was to measure and analyse the concentration of automobile gas component concentration. From measured values the exhaust gas coefficients were determined. From the concentration values and the exhaust gas coefficients, the extent and potential environmental effects of the gases could be predicted. During the survey, the percentages of pollution load by different category vehicles were measured from randomly selected motor vehicles placed in seven categories as shown in Table 4. Whenever feasible at least three (3) vehicles from each class were sampled for analysis.

**Table 4. Pollution load by different categories of vehicles**

Sl. NO	Category of Vehicle	% Pollution
1	Two Wheelers	56.2
2	Three Wheelers	34, 9.08
3	Four Wheelers (Petrol)	12
4	Four Wheelers (Diesel)	2
5	Trucks	18.85
6	Buses	1.54
7	Others	0.26

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There are 57.53 lakhs of Motor vehicles in different categories in Andhra Pradesh state. The vehicular population is increasing day by day and smoke emission from Automobile is causing pollution and also becoming hazardous to health. The total vehicular pollution load (VPL) in twin cities of Hyderabad and Secunderabad alone is 1500 T/day various pollutants released into the atmosphere are detailed below in Table 5.

**Table 5. Total vehicular pollution load (VPL) in twin cities of Hyderabad and Secunderabad**

Sl. NO	Pollutant	% Pollution
1	Co	61.4
2	HC	34
3	NO <sub>x</sub>	3.85
4	SO <sub>2</sub>	0.54
5	SPM	0.18
6	Lead	0.023

The summary of the findings for CO, NO, and NO<sub>x</sub> at idling and at 40 KMPH is given in Table 5 and 6. As seen from these results the highest concentrations are for CO followed by NO<sub>x</sub>. This is as expected from combustion of hydrocarbons, since the composition of hydrocarbons is mainly carbon and hydrogen and nitrogenous compounds are present as impurities. And it can be observed that large vehicles (3.5 ton and above) emit less CO than lighter vehicles for both idling and 40 KMPH cruise. A similar trend, though not to the same degree, can be observed in the other gas components (NO, and NO<sub>x</sub>). Most vehicles below 3.5 ton are run on petrol while those of 3.5 ton and above are run on diesel. The air pollution caused by automobile exhausts gases (ppm by volume) is show in table 6.

**Table 6. Air pollution caused by automobile exhausts gases (ppm by volume)**

Area	Air Pollutants				
	SO <sub>2</sub>	NO <sub>x</sub>	CO	RSPM	TSPM
Abids	5.2	26.6	10	106	311
Jubli Hills	4.7	16.9	8	58	156
Panjagutta	5.0	18.3	5	69	211
Charminar	4.5	16.0	4	54	142

Judging from the evidence from this survey, there is a potential for an increase in air pollution for areas in close proximity to road traffic. This concern is justified taking note of the residential and commercial areas crossed by the Hyderabad city roads. As both present and future Hyderabad roads go through densely populated residential areas, therefore, the impact of automobile exhaust gases described already would definitely be felt by those residents. This study was for the purpose of doing a rapid assessment of road side air concentration for NO<sub>x</sub>, and CO originating from automobile exhaust outside the city centre. These gases may be emitted as a result of incomplete combustion and/or the type and level of impurities present in the fuel. Measurements were taken on the side of roads carrying heavy traffic volumes by using the detector tube method. Measurements were taken during heavy traffic flows at rush hours of the day that is between 07.00 h and 10.00 h and between 15.00 h and 19.00 h.

### VIII. CONCLUSIONS AND RECOMMENDATIONS

In view of the potential for pollution as depicted above, proper traffic air pollution control is one of the missing links in the management of growth and development of Hyderabad City. This points to an obvious need for limiting or preventing automobile air pollution. This should be achieved through deliberate measures to restrict emissions of pollutants from potential sources, banking on best available technology (BAT) as far as possible. More attention has to be focused on reduction of air pollution, and most importantly emphasis should be put on emission standards rather



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than ambient standards. In fact, a nationwide monitoring system and a corresponding database should be the ultimate goal of air pollution prevention and control in Hyderabad, Andhra Pradesh, India.

On top of the above outlined measures for air pollution control, legal and administrative measures have a great role to play. Thus, taking a leaf from practices in other countries, the following legal and administrative measures are applicable<sup>2-10</sup>:

Enacting and enforcement of special laws for control and prevention of air pollution from various sources, including vehicles: the principle of 'the polluter pays' should be applied.

Preventing pollution through stricter issuing of licenses and vetting of imported machinery and vehicles for environmental worthiness: along with this air quality standards should be set.

Other measures that are recommended in a bid to reduce the contribution of automobile emissions to air pollution are:

Spot checks of vehicles for vehicular emissions by authorised expert examiners in coordination with the police to keep polluting vehicles off the road.

A gradual switch to unleaded petrol: use of unleaded petrol will translate into reduction in content of lead in vehicle emissions, hence less lead poisoning.

Discouraging use of diesel vehicles, especially diesel private cars, in favour of petrol cars, since emissions from diesel powered vehicles pose greater air pollution problems: this should go hand in hand with putting restriction on importation of recycled and used cars which have a greater pollution-causing potential because of their obsolete technology and age.

Encouraging use of electric cars/solar cars/hydrogen fuel cells as a means of transport that can help to reduce traffic air pollution whenever applicable.

Increase in bicycle routes to enable more people to take up use of this non-polluting means of transport.

Making the use of catalytic converters (or other similar devices) compulsory to reduce pollutants from automobile exhaust emissions.

Integrating into road projects simple eco-engineering techniques like the planting of appropriate vegetation at roadsides and on parks for absorbing air pollution.

Encouraging development outside the city centre to curb additional housing densification and an increase in traffic in and around the city centre.

It should be borne in mind that, if the present trends in the traffic situation are left unchecked, air quality control could get out of hand necessitating drastic measures like:

Making car-pooling compulsory for vehicles entering the centre of the city.

Permitting vehicles to enter the city centre on a ration basis by restricting vehicles with specific number plates to specific days of the week only.

Introducing an environmental tax on vehicles which have a greater air pollution potential such as those with high fuel consumption rates, recycled cars, etc.

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