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Review Article

A review on Assessment of Air Pollution due to Vehicular Emission in Traffic Area

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Abstract

In Indian metropolitan cities, the extensive growth of the motor vehicles has resulted in the deterioration of environmental quality and human health. The concentrations of pollutants at major traffic areas are exceeding the permissible limits. Public are facing severe respiratory diseases and other deadly cardio-vascular diseases In India. Immediate needs for vehicular air pollution monitoring and control strategies for urban cities are necessary. Vehicular emission is the main source of deteriorating the ambient air quality of major Indian cities due to rapid urbanization. Total vehicular population is increased to 15 Lacks as per recorded data of Regional Transport Organization (RTO) till 2014-2015. This study is focused on the assessment of major air pollution parameters responsible for the air pollution due to vehicular emission. The major air pollutants responsible for air pollution due to vehicular emissions are PM10, PM2.5, Sox, Nox, HC, CO2 and CO and Other meterological parameters like Ambient temperature, Humidity, Wind direction and Wind Speed. Sampling and analysis of parameters is carried out according to National Ambient Air Quality Standards Guidelines (NAAQS) (2009) and IS 5128.

Keywords: *Ambient Air Quality, Vehicular air Pollution, PM10, PM2.5, Sox, Nox, HC, CO2 and CO*

1. Introduction

With rapid urbanization and increase in population, vehicular emissions are increasing day by day. The Diamond City has witnessed a spurt in air pollution due to a very high density of vehicles and shifting back of gas based industries to solid fuel base. Being heavily industrialized, air pollution is a big issue in Surat despite attempts by Gujarat Pollution Control Board (GPCB) to tackle the problem. It is important to measure Air Quality for a healthy life and to preserve environment for future.

Air pollution can be defined as the condition in which air is contaminated by foreign substances which are harmful to humans as well as the environment. Air pollution refers to the increase in amount of green house gases like CH4, N2O and CO2. Air pollution is nothing but the manmade emissions to air. Air pollutants may be in the form of gas, liquid or solid substances that, when present for a sufficient time, in sufficient concentration and under certain conditions, may affect human wealth and may cause damage to the environment.Acid rain, ozone depletion, photochemical smog, natural resource contamination, structural damage, etc. are the results of air pollution. Air pollution includes sources from which air pollutants release, their transport by various meteorological parameters and transformation into secondary pollutants. Air pollutants can be classified as: Natural air pollutants like natural fog, bacteria, pollen grains

a. Gases and Vapors
b. Aerosols (Particulates) like dust, fog, mist, smoke, fumes
c. Primary air pollutants
d. Secondary air pollutants

Natural contaminants are added into the atmosphere from natural sources like pollen grains. Pollen grains are discharged into the atmosphere by the action of wind from grasses, weeds and trees. They may cause irritation to some individuals. Pollen grains may range from 10 to 50μ in the atmosphere. They may responsible for the asthma, bronchitis also. Dust, smoke and mists are the common form of aerosols. Aerosols are the dispersion of liquid and solid particles into the gaseous form in microscopic size. Gases are one of the main sources of air pollution. Pollutant gases are added in the atmosphere through burning of fuels, vehicular emissions, industrial activities, constructional activities, power plants, etc. some of the major gaseous pollutants are carbon dioxide, hydrogen sulphide, oxides of nitrogen, ozone, carbon monoxide, organic vapors.

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Primary air pollutants, which are directly emitted from the man made sources like vehicular emissions, industrial activities, power plants, urbanization and development.

The main primary pollutants that are available in air and are harmful if in high concentration for a long time are as follows:

1) Carbon compounds, such as CO, CO2, CH4, and VOCs
2) Nitrogen compounds, such as NO, N2O, and NH3
3) Sulfur compounds, such as H2S and SO2
4) Halogen compounds, such as chlorides, fluorides, and bromides
5) Particulate Matter.

Secondary air pollutants are those formed by the reaction between the primary air pollutants. They may form by reaction between two or more primary air pollutants under normal atmospheric conditions or under the process of photoactivation. Secondary air pollutants consist of:

1) Ozone
2) Photochemical smog
3) Formation of acid mists (H2SO4) by reaction between sulphur dioxide and dissolved oxygen.
4) Formaldehyde
5) PAN (Peroxy Acetyl Nitrate)

2. Air Pollution due to Road Transport in India

Rapid urbanization and development contribute to the growth of motor vehicles which causes serious impacts on human health and wealth as well as the environment in recent years. Most of the Indian cities are suffered from high traffic problems resulted into the air pollution in the city. Most of the cities are subjected to high levels of NO2, CO, SO2, RSPM (Respiratory Suspended Particulate Matter) and SPM (Suspended Particulate Matter). Vehicular emissions contribute70% of the total environmental pollution in India. Among all the vehicular pollutants CO is the main pollutant coming from the vehicular emissions which contribute 90% of the total emissions followed by Hydrocarbons (HC). Particulate pollution through the road transport is less about 3-5 % of the total vehicular pollution. The SPM and RSPM pollution is subjected to resubmission of dust into the air out of which PM10 is most dominant air pollutant. Oxides of Nitrogen (NOx) are also one of the main air pollutants from transport sector.

Vehicles emissions are becoming major source of air pollution during recent years. India is the second largest developing country in automotive industry. An average of 7-8 million vehicles are produced in India every year. During 2011, India reported 141.8 million registered vehicles. Motorization rate in India is 26 vehicles per 1000 people.

Automobiles are the primary source of air pollution in most of the cities in India. Vehicles emit 261 tones of CO2 out of which road transport contribute 94.5%. in Delhi about 3000 metric ton vehicular pollutants are emitted every day. Similarly urban air pollution in Mumbai is 52% and 33% in Calcutta. Vehicle emissions are responsible for 60% of Green House Gas (GHG) emissions.

Table 1 Vehicle Population as on for the years 1999-00 to 2014-15

Sr. No	Year	Transport Vehicles	Non Transport Vehicles	Total
1	2000-2001	826046	4749994	5576040
2	2001-2002	858113	5149856	6007969
3	2002-2003	899284	5609086	6508370
4	2003-2004	951943	6135597	7087540
5	2004-2005	1016149	6801123	7817272
6	2005-2006	1112590	7509700	8622290
7	2006-2007	1220632	8276705	9497337
8	2007-2008	1313997	8975059	10289056
9	2008-2009	1398189	9600462	10998651
10	2009-2010	1497890	10374683	11872573
11	2010-2011	1621857	11371278	12993135
12	2011-2012	1777974	12635743	14413717
13	2012-2013	1917824	13854629	15772453
14	2013-2014	2027243	15064356	17091599
15	2014-2015	2156394	16564173	18720567

(Source: http://rtogujarat.gov.in/statistics_vehicle.php)

From the recorded data of RTO Gujarat, The vehical population is gradually increasing year by year. It is the one of the major air pollution source of City.

3. Vehicle Emissions from Different type of Vehicles in India

Major Air Pollutant Emissions from Vehicles in India are Carbon Dioxide (CO2), Carbon Monoxide (CO), Oxides of Nitrogen (NOx), Sulfur Dioxide (SO2), Particulate Matter (PM) and Hydro Carbon (HC).

Air pollution is becoming serious problem in most of the Indian cities due to increase in vehicular population. Air pollution due to vehicles includes contaminants like dust, gases, fumes, particulates, smoke etc., which are harmful for human health, plants, animals and environment. Vehicular air pollution contributes 70 to 80% to the total air pollution. Combustion of fuel in motor vehicles releases hundred of chemicals in the atmospheric air. The main pollutants from the motor vehicles are carbon dioxide, carbon monoxide, particulate matter, water vapor, oxides of nitrogen, hydrocarbons, Polycyclic Aromatic

Hydrocarbons, etc. Among all the pollutants from vehicular emission carbon monoxide holds 90% of the total emission in most of the Indian cities. Following are some main pollutants emitted from the vehicular emissions in most of the Indian cities.

Table 2 Major Pollutants emissions from vehicle

Pollutants	Sources
Particulate Matter (PM)	Dust, pollen, sea salt and combustion such as domestic cooking, forest fire, garbage burning, vehicles, ships and railways
Carbon Monoxide (CO)	Incomplete combustion of fossil fuels
Oxides of Nitrogen (NOx)	Diesel engines operated at high temperatures
Sulphur Oxides (SOx)	Oxidation of sulphur during combustion of fuel
Carbon Dioxide (CO2)	Oxidization of carbon during combustion of fuel

3.1 Particulate Matter (PM)

Particulate matter may be in solid, liquid or gaseous form. Particulate may be of primary or secondary. Primary particulate matters are those which are directly emitted from the sources and secondary particulate matter are formed by chemical reaction with other gases. Particulate matters are generally of different size. Their size varies from 0.005 microns to about 500 microns. Particulate matters are classified as PM10, RSPM and PM2.5. Particulate matter having diameter of 10 micron are referred to as PM10. Less than 10 micron diameter particulate matters are called Respirable Suspended Particulate Matter and particulate matters less than 2.5 micron diameter are considered as PM2.5. Now a days PM0.1 are also measured in ambient air quality monitoring in industries which are of size less than 0.1 micron (very fine suspended particulate matters in the air). PM are emitted from various sources like dust, pollen, sea salt and combustion such as domestic cooking, forest fire, garbage burning, vehicles, ships and railways.

3.2 Carbon Monoxide (CO)

Carbon Monoxide is a product of incomplete combustion of fossil fuels. CO emission depends on the air fuel ratio during vehicle engine operation. CO emission increases with decrease in air fuel ration. In India gasoline vehicles are responsible for major CO emissions. Emissions of CO from vehicles operating on diesel are minimal. Use of catalytic convertor can reduce up to 90% CO from the air by converting CO to carbon monoxide.

3.3 Hydrocarbons (HC)

Hydrocarbon emissions from vehicles are due to unburned fuel or incomplete combustion of fuels. Gasoline fueled vehicles without catalytic converter emit 55% HC from engine exhaust system, 20 to 22% HC is emitted from evaporation of fuel from fuel lines, carburetor and fuel tank and 13 to 25% HC is emitted from engine blow by. The HC emissions from diesel operating engine are minimum than the engines operating on petrol. Hydrocarbons can be reduced by providing catalytic converter and converting HC into CO2 and water or by reducing the engine oil entering the engine cylinder.

3.4 Oxides of Nitrogen (NOx)

Nitrogen Oxides are formed during fuel combustion as nitrogen which reacts with the oxygen available in the air at high temperatures. Nitrogen from exhaust recombine with oxygen to form NO and NO2 is formed by oxidation of NO. Diesel engines which operated at high temperatures are responsible for NOx emissions. Diesel cars emit 116.9 gms/km of NOx where as gasoline vehicles emit 3.3 gms/km NOx. NOx emissions can be reduce by reducing temperature in the engine cylinder. Motor vehicles emit 60-70% of NOx in the ambient air. NOx emissions in the ambient air are reduced in India due to the improvements in diesel engine designs.

3.5 Sulphur Oxides (SOx)

Sulphur Dioxide is emitted by oxidation of sulphur during combustion of fuel. Gasoline based vehicles emit negligible amount of sulphur compared to diesel operating vehicles. Diesel fuels in India contain 0.05 to 5% sulphur and are responsible for 2 to 6% of SOx emissions in the ambient air. Sulphur dioxide is responsible for the acid rain and acidifies soils. SO2 levels in the ambient air are decreased in most of the Indian cities because of upgraded low sulphur fuels.

3.6 Carbon Dioxide (CO2)

Carbon available in the fuel is oxidized during combustion of fuel to form CO2. Most of the time carbon in the fuel is not oxidized completely and it is emitted as CO and HC. CO2 emissions increase with the fuel consumption in the vehicles. Hence old and heavy duty vehicles like goods vehicles, buses, trucks emit more CO2 than the other vehicles. Carbon dioxide is the main GHG (Greenhouse Gas). In India 16% CO2 is produced by vehicular emissions out of total CO2 produced from different sources.

4. Health Impacts of Vehicular Emission

CO2 is the main pollutant from vehicular emissions but other vehicular emissions like CO, NOx, HC and SPM are also responsible for adverse health effects. Following table shows health impacts of different vehicular emissions.

Table 3 Health Impacts of Different Vehicular Air Pollutants

Pollutants	Effects on Health
CO	Affects the cardio vascular system, nervous system impairing physical coordination, vision & judgment, creating nausea & headaches, reducing productivity & increasing discomfort
NOx	Causes susceptibility of infection pulmonary diseases, impairment of ling function and eye, nose & throat irritations
SO2	Affects lung function adversely
SPM & RPM	Fine particulate matter may be toxic itself or may carry toxic trace substance & can alter the immune system. Fine particulates penetrate deep into the respiratory system irritating ling tissue & causing long term disorders
HC	Potential to cause cancer

(Source: M N Rao, Air Pollution, 1989)

Following reasons may be responsible for vehicular pollution in urban area.

- Increasing number of older vehicles
- High vehicle density in urban areas
- Minimum use of public transport facilities
- Increasing number of private cars and two wheelers
- Improper traffic management system and road conditions

5. Methodology for Ambient Air Quality Monitoring

Methodology adopted for Sampling and Analysis of various Ambient Air Pollutants are from National Ambient Air Quality Standards (NAAQS) (2009) and IS 5182. Sampling and Analysis details are described further. Table 4 shows details of various ambient air pollutants limits.

Table 4 National Ambient Air Quality Standards (2009)

Pollutants	Time Weighted Average	Concentration in Ambient	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area
SO2 , µg/m3	Annual *	50	20
	24 Hours **	80	80
NO2, µg/m3	Annual *	40	30
	24 Hours **	80	80
PM10, µg/m3	Annual *	60	60
	24 Hours **	100	100
PM2.5, µg/m3	Annual *	40	40
	24 Hours **	60	60
CO, mg/m3	8 Hours **	02	02
	1 Hour **	04	04

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Sampling and Analysis

The Sampling of air pollutants was done using the instrument called High Volume Sampler (HVS). After the completion of sampling time the analysis of the air pollutant sample were carried out. From the derived result, Conclusion and Interpretation of it was taken out and necessary suggestions or preventive measures or future prediction or Air Dispersion is to be found out in order to have better ambient air environment. Table 4 Includes Guidelines for measurement of various parameters.

Table 5 Guidelines for measurement of various parameters

Parameter	Source	Method	Guidelines
NOx	Ambient	Spectroscopy	IS 5182-6
SO2	Ambient	Spectroscopy	IS 5182-2
PM10	Ambient	Gravimetric method	IS 5182-23
PM2.5	Ambient	Gravimetric method	IS 5182-23

6. Future Scope of study

The future scope of ambient air monitoring is described as follows:

- From the derived result of The ambient air quality monitoring study the relationship between Pollutants and meterological parameters can be established.
- The air quality at perticular sampling site can be carried out.
- Effect of meterological parameters on air pollutants can be found out.
- Effect of traffic volume on air pollution can be found out.
- A data set of concentration of different air pollutants can be carried out for the further study of Air Quality Index, air dispersion modelling and Predication analysis study.

Conclusions

Air pollution is something that we cannot really ignore now. There is great evidence linking air pollution with mortality and morbidity in the general population, damage to public health with adverse effects concentrated in urban areas both in developed and developing countries, broad range of adverse health effects affecting both the respiratory and the cardiovascular system which are observed in both short-term and long-term exposures (Brunekreef and Forsberg, 2005; WHO, 2009). However, more recently, it is clear that air pollution and climate change are inexorably linked. Air pollutants are now known to be the keen drivers of climate change.

Exposure assessment and epidemiologic studies in the developing world are important and have advantages. On the one hand, increasing exposure data

of traffic- related air pollution will provide scientific basis for pollution control in local areas. On the other hand, in- depth human health studies in these countries are necessary for assessing the degree of health outcomes of the public and for setting priorities in taking environmental control measures

In addition, epidemiologic investigations in regions with different metrological and socioeconomic backgrounds are helpful in strengthening scientific evidence about the association or causative relationships between these traffic-generated pollutants and various health endpoints.

In recent years, an increasing number of traffic-related pollution exposure studies and epidemiologic investigations have been reported, many of which are under the collaboration of researchers from developed countries and developing countries. Though the volume of scientific investigation on traffic-related air pollutants is increasing, exposure assessment and epidemiologic data are still not abundant. The differences among measuring methods and a lack of strict quality control in carrying out exposure assessment make it difficult for the findings to be generalized and the comparisons to be made between studies, which is especially true in exposure assessment research on particulate matter. Many of the existing epidemiologic investigations conducted in these underdeveloped regions suffer from inaccurate exposure assessment and insufficient control for potential confounders.

References

Ashok Kumar Dubey, Gurdeep Singh George, Bijendre Kumar (2015); Assessment of the impacts of vehicular emissions on urban air quality near highly traffic intersections area of Dhanbad Region, Jharkhand, Indiadz; International Journal of Environment and Natural Sciences, Vol. 5, 6-12

B. M. Prakash, M. Mahadevaswamy, S. Mahesh, Sharadhini. R. Siddhanti (2015); Air Quality Assessment along the Highway Due To Vehicular Emissions and Validation of Air Quality Monitored Data with the CALINEИ Modeldz; International Journal of Innovative Research in Science, Engineering and Technology; Vol. 4, Issue 9

Juned S. Miyajan and Hemangi H. Desai (2015), Diurnal Concentration of Carbon Monoxide (CO) as an Indicator of Vehicular Pollution in Urban Area of Surat City, Gujarat, India, Journal of Energy Research and Environmental Technology, Vol.2, 278-280

P. Balashanmugam, A. R. Ramanathan, V. Nehru Kumar (2012);Assessment Of Ambient Air Quality In Chidambaram A South Indian Towndz; Journal of Engineering Science and Technology Vol. 7, No. 3, 292 – 302

S.M. Shiva Nagendra a, K. Venugopal b, Steven L. Jones (2007); Assessment of air quality near traffic intersections in Bangalore city using air quality indicesdz; Transportation Research Part D 12,167–176

Srimuruganandam Bathmanabhan, Shiva Nagendra Saragur Madanayak (2010); Analysis and interpretation of particulate matter, PM10, PM2.5 and PM1 emissions from the heterogeneous traffic near an urban roadwaydzdz; Atmospheric Pollution Research; 184-194

Xianglu Han, Luke P. Naeher (1989); A review of traffic-related air pollution exposure assessment studies in the developing world; Environment International Book : M N Rao, H V N Rao, Air Pollution, Tata McGraw-Hill Publishing Company Limited, New Delhi, p 4-11 IS 5128

http://rtogujarat.gov.in/statistics_vehicle.php