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Ambient Air Quality Monitoring In Pune City

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Abstract: ***The rapid growth of a Pune city and surroundings has a profound impact on the air by vehicular emissions. This is especially true in the developing world, mainly due to high proportion of old, poorly maintained vehicles and poor fuel quality. On 9th May, 2002 the Supreme Court of India issued order in W.P. No. 13029 of 1985 directed that a scheme be prepared for improvement of air environment with special reference to vehicular pollution. The Supreme Court of India directed to include Pune City, as one of the four cities. The Air quality of the Pune city day by day will change and goes on the benchmark of pollution. Presently MPCB and IMD monitored air quality of Central Pune city on continuous and intermittent basis. This paper and study has main aims to develop effective monitoring mechanism to monitor the concentration of CO and NO_X at existing and new monitoring stations and includes scenario of gaseous air pollutants due to vehicular emission in different areas of Pune city and surroundings so that the station wise air quality and its respective parametric concentrations will analyzed.***

Keywords: Air Pollutants, CO, Monitoring station, NO_X, Vehicular Emission

1. Introduction

Air is one of the most important constituents of man's environment. An average human being requires about 12 kg of air each day, which is nearly 12 to 15 times greater than amount of food consumed. Any change in natural and normal composition of the air, that may adversely affect the living system, particularly the human life, invariably causes air pollution. The air pollution on Earth originated when the man started using firewood for cooking and heating purposes [1]. The pollutants like dust, smoke, gases and fumes may be either from natural or manmade sources. The sources of air pollutants include vehicles, industries, domestic sources and natural sources. Because of the presence of high amount of air pollutants in the ambient air, the health of the population and property is getting adversely affected.

Ambient air quality monitoring is carried out so as to generate data that meets the objectives of monitoring. Ambient air quality monitoring programme are needed to determine the existing quality of air, evaluation of the effectiveness of control programme and to develop new programme. Sources of air pollution include products of combustion such as nitrogen oxides (NOx), carbon oxides (COx), sulphur oxides (SOx) [2]. In the city Centre's especially on highly congested streets, traffic can be responsible for as much as 90-95% of the ambient CO levels, thereby posing a significant threat to human health and natural resources.

The rapid growth of a city has a profound impact on the air vehicular emissions. This is especially true in the developing world, mainly due to high proportion of old, poorly maintained vehicles and poor fuel quality. Automobiles exhausts release gaseous pollutants primarily from the incomplete combustion of carbonaceous matters. It contains, nearly two third of CO and one half of the hydrocarbons and nitrous oxides [3].

The Hon'ble Supreme Court of India in their Order dated 9th May, 2002 in W.P. No. 13029 of 1985 directed that a scheme be prepared for improvement of air environment with special reference to vehicular pollution in cities other than Delhi, which are equally or more polluted. Directives were given by the Hon'ble Supreme Court of India to include Pune City, as one of the four cities, which further studies in order to prepare an action needed plan as per those directives for an air quality improvement [4].

2. Literature Review

Air is the earth's atmosphere. It is the clear gas in which living things live and breathe. It has an indefinite shape and volume. It has no color or smell. It has mass and weight. It is a matter as it has mass and weight. Air is a mixture following gases as shown in table.

Table 1: Composition of Air [5]

Constituent	*Chemical Symbol*	*Mole Percent*
Nitrogen	N_2	78.084
Oxygen	O_2	20.947
Argon	Ar	0.934
Carbon Dioxide	CO_2	0.0350

CO is a colorless and odorless gas which when released into the atmosphere plays an important role in global, regional and urban atmospheric chemistry by affecting the concentration of hydroxyl radical (OH) and the cycle of troposphere ozone (O_3) [6]. Symptoms of mild acute poisoning will include light-headedness, confusion, headaches, vertigo, and flu-like effects; larger exposures can lead to significant toxicity of the central nervous system and heart, and even death. Carbon monoxide combined with hemoglobin to form carboxyhemoglobin (Hbco) in blood.[7].

Anthropogenic sources of air pollution include products of combustion such as nitrogen oxides (NOx), carbon oxides (COx), sulphur oxides (SOx). Indeed motor vehicles produce more air pollution than any other single human activity. Nearly about 50% of global CO emissions from fossil fuel combustion come from gasoline and diesel powered engines.

It is easily absorbed through the lungs. CPCB provides standard of air pollutants concentration in ambient air,

beyond this limited value of particular pollutants causes' health problem. Pollutant concentration with their time of exposure given below

Table 2: Desirable limits of air pollutants [8]

Sr. No.	Pollutants in ($\mu g/m^3$	Concentration in Ambient Air		
		Time Weighted Average	Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area
1	Sulphur Dioxide (SO_2),	Annual *	50	20
		24 Hrs.**	80	80
2	Nitrogen Dioxide (NO_2),	Annual *	40	30
		24 Hrs.**	80	80
3	PM (Size <10µm)or PM10	Annual *	60	60
		24 Hrs.**	100	100
4	PM (Size<2.5µm) or PM2.5	Annual *	40	40
		24 Hrs.**	60	60
5	Carbon Monoxide (CO), mg/m^3	8 Hrs. *	02	02
		1 Hr.**	04	04
6	Ozone (O_3),	8 Hrs. *	100	100
		1 Hr.**	180	180
7	Lead (Pb),	Annual *	0.50	0.50
		24 Hrs.**	1	1

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform interval.
** 24 hourly 08 hourly or 01 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.

The population and residents of Pune city, the economic and administrative capital of Pune city has increased rapidly in the last decade, and in the absence of a reliable public transport system, air pollution has worsened because of an increased number of old second-hand cars, auto-rickshaw, motorbikes, substandard gasoline and other products imported into the city. It is anticipated that air pollution will become a major health problem if adequate mitigation measures are not taken. This study presents the levels of gaseous in different areas of Pune city, which arises as a result of increased high vehicular emission due to poor public transport. Ambient air quality monitoring is carried out so as to generate data that meets the objectives of monitoring. Ambient air quality monitoring programmed are needed to determine the existing quality of air, evaluation of the effectiveness of control programmed and to develop new programmed.

Table 3: Features of Pune city [12]

Particulars	*Corresponding Values*
Area of Pune city	243 km^2(approx.)
Population (2011)	36,04,323
Projected Population 2021	51,82,952
Average Rainfall	600 to 700 mm
Minimum/Maximum temperature	12^0C and 37^0C
Relative Humidity	59.3%

3. Methodology

The paper aims towards developing a more uniform air monitoring network so that data from various stations is comparable. The various aspects of air quality monitoring network such as, which pollutants should be monitored, location of monitoring station and the various techniques of monitoring. The legal requirements in Pune for carrying out ambient air quality monitoring are also discussed. These requirements serve as basis on which objectives of ambient air quality monitoring are determined. The ambient air quality monitoring network involves measurement of a number of air pollutants at number of locations in the country so as to meet objectives of the monitoring.

3.1 Air Quality Monitoring

Ambient air quality monitoring is required to determine the existing quality of air, evaluation of the effectiveness of control programme and to identify areas in need of restoration and their prioritization. National Air Quality Monitoring Programme is described in this paper along with details on pollutants measured and their frequency. Guidelines for monitoring are made for carrying out ambient air quality monitoring under NAMP and description of the programme is essential as the monitoring is carried out to meet the objectives of NAMP.

3.2 Procedure for Monitoring

For setting up of any ambient air quality monitoring station, the most important thing to be considered prior to commencement of actual monitoring is to collect its background information.

3.2.1 Background Information

The background information that needs to be collected includes details of sources and emissions, health status, demography, population growth, land use pattern, epidemiological studies. Such prior information will provide immense help to identify the likely effects and in particular health impacts resulting from population exposure to air pollutants.

3.2.2 Sources and Emissions

Sources in a city include vehicles, industries, domestic etc. In an industrial area, information should be obtained on the type of industries including their number, fuel used, composition of fuel, pollutants emitted etc. Information on number and distribution of sources should be collected. This information will help in identifying which pollutants can be expected in an area and thus should be measured. In case of industrial stacks, locations of maximum ground level concentrations should be determined by modeling. The stations should be located at locations where maximum ground level concentrations are expected. Information on type and number of vehicles should be obtained. Information on domestic fuel that is used in household should be obtained. Pollution load emanating from these sources should be estimated so as to identify sources that are generating significant amount of pollution.

3.2.3 Health and Demographic Information

Investigations shall be carried out based on the public complaints received from an area related to air pollution. If the results of such investigations reveal that the levels are high that area can be considered for ambient air quality monitoring. Areas where population density is high (more than one million) can be considered for locating monitoring stations. Information on age and socio-economic status of population is also important for making a decision on initiation of ambient air quality monitoring. Location of monitoring station in such areas will help in finding exposure levels to population which can be used further in epidemiological studies to evaluate health effects of air pollutants.

3.2.4 Meteorological Information

Meteorological data with respect to temperature, relative humidity, wind speed and direction should be collected. Predominant wind direction plays an important role in 10 determining location of monitoring stations. Due to effects such as land and sea breezes, valley effects etc. it is important to collect local meteorological data specific to the site. The monitoring stations should be located in areas that are downwind from the sources. Mixing height data should also be collected. Mixing height data can be collected from Indian Meteorological Department. Information on duration of various seasons in a year is also important. Measurement frequency should be such that monitoring is done in all the seasons so that all seasonal variations are included in computing annual average.

3.2.5 Topographical Information

Local winds and stability conditions are affected by topography. In river valleys there is increased tendency of developing inversions. More number of monitoring stations should be located in areas where spatial variations in concentrations are large. Mountains, hills, water bodies also affect dispersion of pollutants.

3.2.6 Previous Air Quality Information

Any previous information collected on ambient air quality can serve as a basis for selecting areas where monitoring should be conducted and previous studies may include data collected for any health studies etc. Previous studies can be used to estimate the magnitude of the problem. Once the background information is collected, the ambient air quality monitoring is to be initiated and selection of type of pollutant to be measured, number and distribution of monitoring stations etc. should be made.

3.3 Number and Distribution of Monitoring Locations

Knowledge of existing air pollutants levels and pattern within the area are essential for deciding number and distribution of stations. Isopleths distribution of ambient concentrations determined from modeling or previous air quality information can be used to determine number and distribution of stations. When isopleths maps are not available information of emission densities and land use pattern may be used with wind-rose data to determine areas of expected higher concentrations. The number of monitoring stations in a city can be selected based on background information collected on sources and emissions, Population figures which can be used as indicators of region variability of the pollutants concentration.

3.4 Selection of Monitoring Location

Principal factors governing the locations of the sampling stations are the objectives, the particular method of instrument used for sampling, resources available, physical access and security against loss and tampering. Air quality monitoring should be done in areas where pollution problem exists or is expected i.e. mainly in industrial areas, urban 21 areas, traffic intersections etc. One of the objectives of monitoring is to determine status and trends and the air quality monitoring should be done in metropolitan cities and other urban areas so as to compare their levels and determine trends. Selection of site is very important as an incorrect location may result in data that may not meet the objectives of monitoring and will be of limited value. In general the following requirements should be satisfied for site selection. The site should be away from major pollution sources. The distance depends upon the source, its height and its emissions. The station should be at least 25 m away from domestic chimneys, especially if the chimneys are lower than the sampling point; with larger sources the distance should be greater (WHO, 1977). The site should be available for a long period of time; Easy access to the site should be there anytime throughout the year.

3.5 Topographical and Meteorological Factors

Topographical and meteorological factors must also be considered for selecting a monitoring site. The topographical factors that must be considered are mountains, valleys, lakes, oceans and rivers. These factors cause meteorological phenomena that may affects air pollutants distribution. Winds caused by daytime heating and nighttime cooling may affect pollutant transport causing either buildup of pollutants or dilution. Canyons or valleys may channel the local winds into a particular direction resulting in increase in wind speed. The presence of 24 large water bodies may cause a land-sea breeze wind pattern which may determine pollutant transport. The mountain or hilly terrain may cause precipitation that may affect pollutant concentration.

3.6 Selection of Pollutants

Prior to selection of pollutants, an emission inventory study or modeling results can be carried out or used if available. The pollutants expected from the sources present should be monitored. For monitoring in metropolitan cities and urban areas, the common urban air pollutants such as carbon monoxide, SO_2, NO_2, SPM and RSPM should be measured on a regular basis. Resource availability can play a very important role in determining the pollutants to be measured in an area.

The pollutant selection criteria are as follows:

3.6.1 Criteria for NO_2 Measurements [13]

NO_2 is formed in the atmosphere by reaction of nitric oxide (NO) with ozone and hydrocarbons (HC). Thus high NO_2 levels are expected at locations where NO, ozone and

hydrocarbons levels are high. Generally areas with high population and traffic are chosen for measuring NO_2. Since ozone is formed downwind from the sources, NO_2 levels downwind from the sources can also be high provided NO is also present in sufficient quantity.

3.6.2 Criteria for CO Measurements [13]

CO is emitted from vehicles and its measurement should be conducted near traffic intersections, highways, commercial areas with high traffic density. Generally areas with high population density also have high vehicles and higher CO levels and these areas should also be considered for conducting CO measurements.

3.6.3 Sampling Duration and Frequency

The period and frequency of sampling should be such that statistically reliable averages can be obtained with the data. National Ambient Air Quality Standards states that annual average should be computed of 104 measurements taken twice a week of 24 hours duration. One of the objectives of monitoring under NAMP is to determine compliance to the NAAQS so monitoring should be done for 24 hours and minimum 104 days in a year.

The precision required in the data is also important in determining frequency of sampling. Sampling should be more frequent than the frequency of variation of pollutants. Particulate matter levels are lower during the monsoon months due to removal by wet deposition [14].

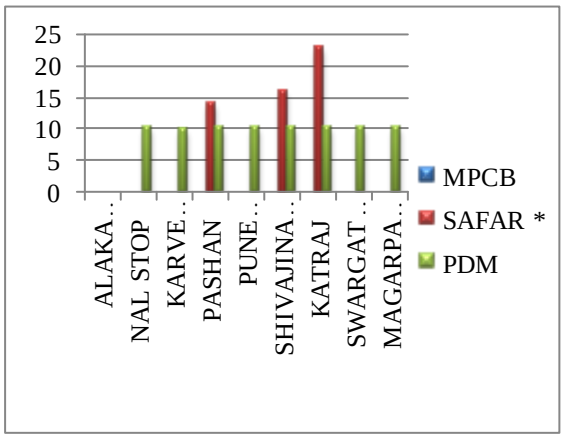
3.7 Measurement Methods

Measurements of concentration of gaseous pollutants is carried out by Proposed developed mechanism (PDM). Monitoring will be carried out by twice in week at every AQMS located by MPCB, SAFAR, and our proposed sites.

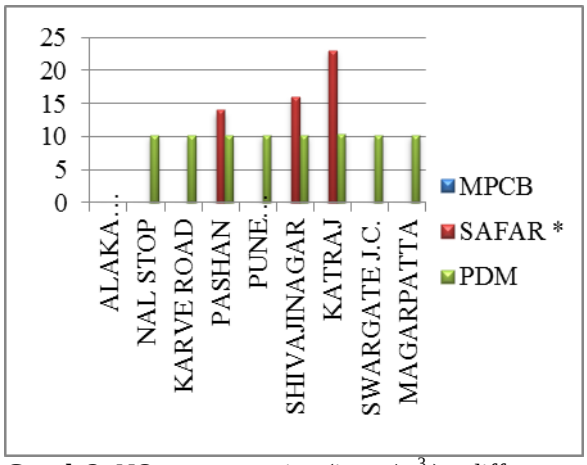
Table 5: Proposed Air Quality Monitoring Stations

Sr. No.	Existing Stations Within Pune		Proposed AQMS
	SAFAR AQMS	MPCB AQMS	
1	Pashan	Karve Road	Pashan
2	Shivajinagar	Nal stop	Shivajinagar
3	Katraj Snake Park	Swargate J.C.	Katraj Snake Park
4	Alka Talkies Chowk	NA	Swargate J.C.
5			Alka Talkies Chowk
6			Karve Road
7			Nal stop
8			Pune University
9			Magarpatta,Hadapsar

4. Result and Discussion



Graph 1: CO concentration (in mg/m^3) at different stations



Graph 2: NO_X concentration (in $\mu g/m^3$)at different stations

***** SAFAR unit of concentration is not define

4.1 Graph 1 showing monitoring of CO at proposed and existing monitoring station. Two days data were collected and compared with data of stations which are operated by MPCB and SAFAR. It is clearly seen there is considerable difference between data of different system. MPCB is not performing any activity for determination of CO, so it showing zero value at every station.

4.2 Graph 2 showing monitoring of NO_X at proposed and existing monitoring station. For NO_X monitoring again two days data were collected at every stations and compared with data of stations which are operated by MPCB and SAFAR. It is clearly seen that there is large difference in monitoring of NO_X when analyzing with different system.

5. Conclusion

Pune City is rapidly growing in each sector and today's growth is sign that city become metro city within short period. Vehicular emission continuously deteriorates air quality of city and effecting on climate. February and March months' temperature is exceeding year by year and rainfall occurs in staggered way. There is need of effective network of air quality monitoring stations to get appropriate data of polluted area. Analysis of collected data will be done fast with suitable mechanism so accordingly to take effort for improvement of air quality.

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