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A STUDY FOR DETECTING AIR POLLUTANT'S CONCENTRATION IN VADODARA, GUJARAT, INDIA.

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ABSTRACT : The rapid development in urban India has resultedin a tremendous increase in the number of motor vehicles. In some cities, this has doubled in the last decade. Fast urbanization and development of engine vehicles force a serious impact on human existence and the climate lately. Motor vehicles are a significant source of urban air pollution and are increasingly important contributors of anthropogenic carbon dioxide and other greenhouse gases. Transport area contributes a significant area, contributing 90% of all out emissions. Air contamination is a serious ecological wellbeing danger to people. Vehicular activities & on-road vehicles are one of the major contributors for reduction of urban air quality. Vehicular emission is the major contributor of primary and secondary pollutants to the ambient air. Health problems related with respiratory and cardiovascular systems of the human body are resulted by exposure to poor air quality.

The document presents a review of the vehicular emission problems in Vadodara city at the location of vrundavan crossroads having distance taken 1000 meter from all four directions. This review study involves the points regarding serious effects of vehicular pollution & the solutions to vehicular pollution. In addition, there are some of the pros & cons along with the applications for using air dispersion modelling to minimize the environmental deteoration and improve the ambient air quality.

KEYWORDS: CPCB- Central Pollution Control Board, NAAQS- National Ambient Air Quality Standard, PM- Particulate Matter, SPM- Suspended Particulate Matter, TSP- Total Suspended Particle.

1. INTRODUCTION

On-road vehicles are the main source of urban air pollution which contributes to poor air quality On-road vehicles produce large amounts of primary pollutants and some of them also contribute to production of secondary pollutants & secondary aerosols. Air pollution in city originates mainly from the local sources. Local sources include local transportation, public & construction activities, etc. Ambient air quality in city is also affected by air pollution from industries located around. Poor air quality can affect respirational and cardiac systems of the human body. Exposures to such traffic related air pollution lead to many cardio-respiratory diseases and mortalities as suggested by many epidemiological studies. As the awareness regarding effects to body of vehicular emissions rises, countries implement policies to reduce the human exposure to air pollutants. These policies are generally evaluated through the practice of simulation tools which estimate traffic counts, vehicular emissions, ambient air concentration of pollutants, and human exposure. As expected, the accuracy of estimating human exposure largely relies on the accurateness of estimated ambient air concentrations. Complex combinations of air contamination are transmitted from industries, families, vehicles and trucks, large numbers of which are hurtful to wellbeing. The fine particulate matter has most noteworthy impact to people out of these contaminations. Fuel combustion of vehicles, households or biom ass burning both from stationary sources such as industry and from mobile sources such as vehicles leads to generation of most fine particulate matter. Broad spectrum of critical and long-lasting illness, lung cancer, chronic obstructive pulmonary disease (COPD) and cardiac diseases are associated with air pollution. Ambient air pollution was responsible for around 4.2 million deaths in the year 2016. Globally, ambient air pollution is projected to cause about 16% of the lung cancer deaths, 25% of COPD deaths, about 17% of ischaemic heart disease and stroke, and about 26% of respiratory infection deaths.

A large portion of the Indian Urban communities are likewise encountering fast urbanization and most of the country's population is supposed to be living in urban areas inside a range of next twenty years. Since poor encompassing air quality is to a great extent a metropolitan issue this will straightforwardly influence a large number of the occupants in the urban communities.

2. AIR POLLUTION

Air pollution is one of the serious environmental concern of the urban Asian cities including India where majority of the population is exposed to poor air quality. The health related problems such as respiratory diseases, risk of developing cancers and other serious ailments etc. due to poor air quality are known and well documented. Other than the health effects, air contamination likewise adds to enormous economy losses, particularly in the feeling of financial assets that are expected for giving clinical help to the impacted people. The poor are often the most affected segment of the population as they do not have adequate measures to protect themselves from air pollution. Most of the Indian Cities are also experiencing rapid urbanization and the majority of the country's population is expected to be living in cities within a span of next two decades. Since poor ambient air quality is largely an urban problem this will directly affect millions of the dwellers in the cities.

3. AIR POLLUTANTS

The air pollutants can be classified as primary or secondary pollutants. The human activities are one of the reasons for entering of such primary air pollutants are harmful chemicals in the air. The chemical reaction between two or more components in the air results in the production of secondary air pollutants which is harmful chemical. A secondary air pollutant is a harmful chemical produced in the air due to chemical reaction between two or more components. That is primary pollutant combines with some component of the atmosphere to produce a secondary pollutant. Among the most common and poisonous air pollutants, when fossil fuels such as coal, gas and oil are utilized for power generation leads to the formation of sulphur dioxide (SO2), suspended particulate matter (SPM), solid and liquid particles emitted from numerous man -made and natural sources such as industrial dust, volcanic eruptions and diesel-powered vehicles; and natural sources such as lightning, fires results in formation of nitrogen oxides (NOx). CPCB initiated National Ambient Air Quality Monitoring (NAAQM) programme with 7 stations at Agra and Anpara in the year 1984. Subsequently in 1998-99 it was renamed as National Air Monitoring Programme (NAMP). The number of monitoring stations under NAMP has increased, steadily, to 295 covering 98 cities/towns in 29 States and 3 Union Territories of the country by 2000-01. Under NAMP, four air pollutants viz., Sulphur Dioxide (SO2), Regular monitoring at all the locations for pollutants like Total Suspended Particulate (TSP), Oxides of Nitrogen as NO2, and Respirable Suspended Particulate Matter (RSPM/PM10), have been identified (CPCB, 2002).

The pollutants those are under study for ambient air monitoring in this review paper: -

1. Particulate matters PM10 & PM2.5
2. Sulphur Dioxide as SO2,
3. Oxides of Nitrogen as NOx.

4. NEED OF THE STUDY.

The contribution of emissions from vehicles plays a major part in declining of ambient air quality. The need of such model study would help as the early warning systems in order to have the opportunity to take promising and precautionary action to reduce pollutants when conditions that encourage high concentrations are predicted.

This review study involves the points regarding serious effects of vehicular pollution & the solutions for vehicular pollution. Also, the discussion of effects, advantages and disadvantages has been clearly mentioned for these harmful pollutants. In addition, the applications for using air dispersion modelling & traffic survey to minimize the environmental deteoration and improve the ambient air quality is also given in detail.

5. VEHICULAR POLLUTION

Vehicular pollution is the introduction of harmful material into the environment by motor vehicles. These materials, known as pollutants, have several bad effects on human health and the ecosystem. Transportation is a major source of air pollution in many countries around the world due to the high number of vehicles that are available on the roads today. An increase in purchasing power means that more people can now afford cars and this is bad for the environment. Vehicular pollution has grown at an alarming rate due to growing urbanisation in India. The air pollution from vehicles in urban areas, particularly in big cities, has become a serious problem. The pollution from vehicles has begun to tell through symptoms like cough, headache, nausea, irritation of eyes, various bronchial and visibility problems.

6. VEHICULAR POLLUTANTS

Automotive vehicles emit several pollutants depending upon the quality of the fuel they consume and engine efficiency. The release of pollutants from vehicles also include fugitive emissions of the fuel and the source and levelof these emissions depending upon the vehicle type, its maintenance, etc.

- Particulate matter- These particles of soot, metals, and pollengive smog its murky color. Among vehicular pollution, fine particles pose the most serious threat to human health by penetrating deep into lungs.
- Nitrogen oxides- These vehicular contaminations can cause lungirritation and weaken the body's guards against respiratory diseases like pneumonia and flu. In addition, they assist in the formation of ozone and particulate matter
- Sulfur dioxide- Motor vehicles create this pollutant byburning sulfur-containing fuels, especially diesel. It can react in the atmosphere to form fine particles and can pose a health risk to young children and asthmatics.
- Hazardous air pollutants- These chemical compounds, whichare emitted by cars, trucks, refineries, gas pumps, and related sources.
- Carbon monoxide- This odorless, colorless gas is formed bythe combustion of fossil fuels such as gasoline. Cars and trucks are the source of nearly two-thirds of this pollutant. When breathed in, CO impedes the vehicle of oxygen to the brain, heart, and other

imperative organs in the human body. Newborn children and people with chronic illnesses are especially susceptible to the effects of CO.

7. TRAFFIC SURVEY IN THE STUDY AREA

The vehicular movement in the study region mainly comprises activities such as Local goods transportation, public transportation, and the study region i.e., Vrundavan chokdi being education hub the major type of vehicle movements in the region are of 2 & 3 wheelers, Passenger car, and College Buses. There are various road junctions and cross roads within the town and thus the traffic survey was performed at Study location for identifying traffic volume count and use further for the town and which can be selected further for performing Ambient Air Monitoring & Dispersion modelling for the Vrundavan chowkdi.

PCU CALCULATION FOR THE VRUNDAVAN CHOWKDI

It is the amount of interaction (or impedance) caused by the vehicle to a traffic stream with respect to a standard passenger car. It is used to convert a heterogeneous traffic stream into a homogeneous equivalent to express flow and density in a common unit.

The calculation of PCU was done for each hour and for each vehicle type recorded at Vrundavan. Passenger car unit value values (factors) considered for calculation are shown in the below table:

PCU = Passenger car unit value (Factor) x Number of vehicles

Table 1 Passenger car unit values (factors) as per IRC Code No. 106:1990

Sr. No.	Vehicle Type	PCU Value
1.	Two-Wheeler	0.5
2.	Auto Rickshaw (3Wheeler)	1.2
3.	Car/Jeep/Van	1.0
4.	Mini Bus	1.4
5.	Bus	2.2
6.	Light Commercial Vehicle (LCV)	1.4
7.	2 & 3-Axle Truck	2.2
8.	M-Axle Truck	4.0
9.	Tractor	4.0
10.	Cycle	0.5
11.	Other	3.0

The average per hour PCU for each vehicle type was determined after using the above-mentioned values in calculation for determining the Passenger car unit. The road length and width were measured for the roads of the Vrundavan i.e. Uma chowkdi to Vaikunth and Parivar to Khodiyarnagar. For the study work, geometry of the roads i.e., Length and Width of the roads are required as the input data source for the Line Source Dispersion Modelling. The measurements of the roads are shown in the below table:

Table 2 Length & Width of the Road

Road	Road Length	Divider Width (1)	Lane Width (2)	Footpath Width (3)	Total 4= (1) +(2) +(3)
Uma chowkdi to Vaikunth	2000 m	0.5m & 4.5 m	7.00 m + 7.00 m	4.45 m	11.45 m & 15.95m
Parivar to Khodiyarnagar	2000 m	0.5m & 4.5m	7.00 m + 7.00 m	4.45 m	11.45 m & 15.95m

8. DISPERSION MODELLING

Air quality modelling is a mathematical tool used to predict and simulate the distribution and the behaviour of air pollutants emitted to the atmosphere. It describes the causal relationship between emissions, meteorology, atmospheric concentrations, deposition, and other factors. Air contamination estimations give significant, quantitative data about surrounding fixations and statement, but they can portray air quality at explicit areas and times, without giving clear direction on the distinguishing proof of

the reasons for the air quality issue. A more complete deterministic depiction of the air quality problem can be known via air pollution modelling, including an investigation of elements and causes (emission sources, meteorological cycles, and physical and chemical changes), and some guidance on the implementation of mitigation measures. Air pollution cannot be measured in every point for particular area because it requires a lot of money and time. Therefore, by the help of air pollution models, one can for example determine the suitable points for making pollution measurements. Due to their capability to assess the relative importance of the relevant process air pollution models play a vital role. The relationship between emissions and concentrations/depositions can be quantified only by the methods of air pollution models, including the consequences of past and future scenarios and the determination of the effectiveness of abatement strategies. This makes air pollution models indispensable in regulatory, research, and forensic.

The purpose of these air pollution models is to quantitatively combine the effects of source strength and meteorology to describe the resulting ambient air pollution concentration. Meteorology is affected by wind speed and direction, atmospheric stability, inversion height, and terrain features. Ambient air pollution concentrations occurring downwind of a source consist of two components pollution contributed directly by the source and the background pollution. Useful mathematical model must be able to account for all these parameters. The computer programs for most of the modern air pollution models that calculate the pollutant concentration downwind of a source using material on the:

- Contaminant emission rate
- Characteristics of the emission source
- Local topography
- Meteorology of the area
- Ambient or background concentrations of pollutant

A generic overview of how this information is used in a computer-based air pollution model is shown in below figure:

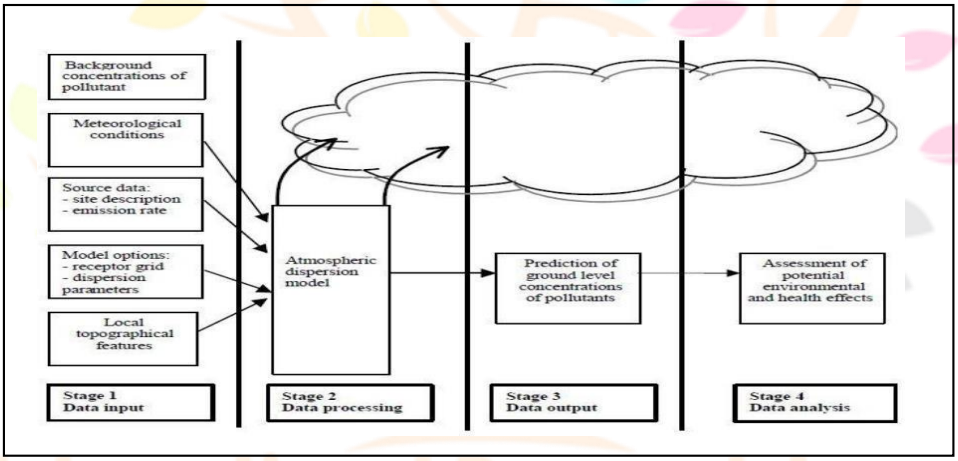

Figure:- 1 Generic overview of information used in a computer-based air pollution model

9. SOFTWARES FOR DISPERSION MODELLING

Contaminations released out of sight are moved over significant distances by large scale air-flows and are scattered by small-scale air-flows or disturbance, which mix pollutants with clean air. This dispersion by the wind is an exceptionally complicated process because of the presence of various sized eddies in atmospheric flow. Even under ideal conditions in a laboratory the dynamics of turbulence and turbulent diffusion are some of the most difficult in fluid mechanics to model. The causative meteorological factors, processes and ambient concentrations of air pollutants have no complete theory showing the relationship between both.

The estimation by calculating of the basic information about the source of the pollutant and the weather conditions are the main objective.

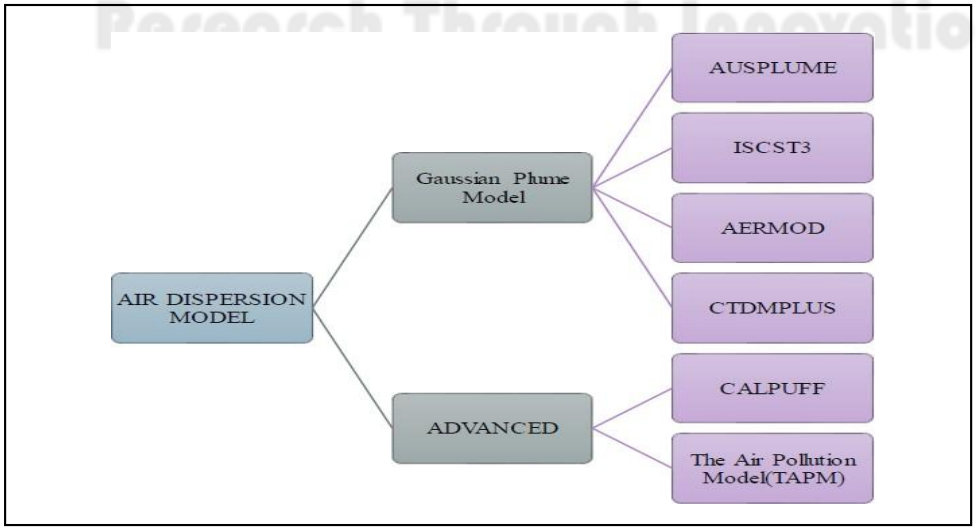

Figure:- 2 Various Air Dispersion Models

The above shown are some of the dispersion models used for dispersion based on the type of source for pollutant generation. Aermod has been used for the study work to perform the dispersion modelling.

10. ADVANTAGES OF AIR DISPERSION MODELLING

Vital part of an effective air quality management system is ambient air monitoring. Reasons to collect such data include to: Assessing the extent of pollution:

- Providing air pollution data to the common public in a timely manner;
- Supporting implementation of air quality goals or criteria;
- Evaluating the effectiveness of emissions control strategies;
- Providing statistics on air quality trends;
- Providing data for the evaluation of air quality models; and
- Supporting research (e.g., long-term studies of the health effects of air pollution).
- Measurement of any pollutant can be done by different. Which methods are most appropriate, initial investment costs for equipment, taking into account the main uses of the data, reliability of systems, ease of operation, and operating costs should be inspected by the developer of a monitoring plan.
- The purpose of the monitoring states the locations for monitoring stations. The design of the majority of the air quality monitoring systems is done to support human health objectives, and monitoring stations are established in population centres. They may be near busy roads with traffic, in city centres, or at locations of particular concern (e.g., particular emissions sources, a school, hospital,). The other practice of establishing the monitoring stations is to determine background pollution levels, away from emissions sources and urban areas.
- Ensuring that data are of acceptable quality, to record and store the data, and to analyse the data and present results are needed to be considered for structures.

11. EFFECTS OF VEHICULAR POLLUTION

- Global Warming
- Poor Air Quality
- Reduced Visibility
- Health Issues and Complications
- Acid Rain

12. SOLUTIONS TO VEHICULAR POLLUTION

- Drive Less
- Governmental intervention
- Invest in zero-emission vehicles
- Burn Fewer Fuels
- Having in Place Pollution Control Technologies
- Civic Education
- Discarding Old Vehicles
- Control the formation of nitrogen oxide by investing in novel designs.

13. CONCLUSION

Growing motorization would lead to increase in the vehicle movements in the study area and surrounding in the coming future this shall lead to increase in the pollution occurring from such vehicular movements. In this age of rapid advancement air pollution due to automobiles has become a critical concern for the environment. Today, in almost every country the majority of population is exposed to the poor quality of environment. The human beings have become vulnerable to different disease starting from a headache to serious diseases such as lungs cancer. This indirectly leads to the economic loss of a country as financial resources are need to be spent for providing required medical facilities to the affected public.

Thus, the research work would include the traffic volume count also monitoring & sampling of the various air pollutants i.e. PM10, PM2.5, NOx, & SO2. In addition, the traffic volume count or the traffic survey would be done with the guildlines given by Indian Road Congress. Selection, trial & error would be conducted on the Air Dispersion Modelling software for the given parameters.

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