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Use of Activated Alumina Filter in Vehicles to Reduce Air Pollution

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Abstract —*Clean air is the basic requirement for survival of life on earth. But due to urbanization and industrialization, the amount of pollutants in the atmosphere has been increased. Amongst major sources of pollution, the main contributor for increment is the vehicular pollution which accounts about 70% of the total air pollution. There is a substantial growth in number of vehicles in the past years which increased the pollution. For determining the controlling measures to reduce the air pollution especially at highly impacted vehicle traffic crossings, the monitoring of ambient air quality becomes essential. Such monitoring was conducted during peak hours at Akota- Dandia bazar crossing which connects highly populated urban areas of Vadodara city. The value of PPM10 was found higher than the permissible limit. To remedy this, a filter unit is developed and proposed which has been observed reducing the pollutant load considerably.*

Keywords-*Ambient air quality; High Volume Sampler; Permissible limits; Air pollution*

Abbreviation:

PUC	*Pollution Under Control*
CO	*Carbon Monoxide*
HC	*Hydro Carbon*
CO2	*Carbon Dioxide*
O2	*Oxygen*
NOx	*Nitrogen Oxide*
PPM10	*Particulate Matter*
AAP	*Ambient Air Pollution*

I.INTRODUCTION

Air pollution is the introduction of harmful substances including particulates and biological molecules into Earth's atmosphere. Air pollutants are added in the atmosphere from variety of sources that change the composition of atmosphere and affect the biotic environment. The concentration of air pollutants depends not only on the quantities that are emitted from air pollution sources but also on the ability of the atmosphere to either absorb or disperse these emissions.

Clean air is the foremost requirement to sustain healthy lives of humankind and those of the supporting ecosystems which in return affect the human wellbeing. Release of various gaseous emissions and particulate matter (PM) has been on the rise due to rampant industrialized growth Anthropogenic emissions of various kinds are being pumped into the atmosphere (called primary pollutants) and lead to the formation of new pollutants due to chemical reactions in the atmosphere (called secondary pollutants). These are building up the concern of Ambient Air Pollution (AAP) as a prominent global threat to human health in many ways.

Currently, in India, air pollution is widespread in urban areas where vehicles are the major contributors and in a few other areas with a high concentration of industries and thermal power plants. Vehicular emissions are of concern since these are ground level sources and thus have the maximum impact on the general population. Also, vehicles contribute significantly to the total air pollution load in many urban areas.

Rapid urbanization and growth of motor vehicles impose a serious effect on human life and its environment in recent years. This problem is more prevalent in metro cities as the volume of traffic is more due to high population. Also, due to this other cities and villages are also affected. Due to rapid urbanization the demand of transport sector has increased and therefore the number of vehicles has increased. The **Figure1** represents the rise in number of Registered Vehicles under various categories in India per decade.

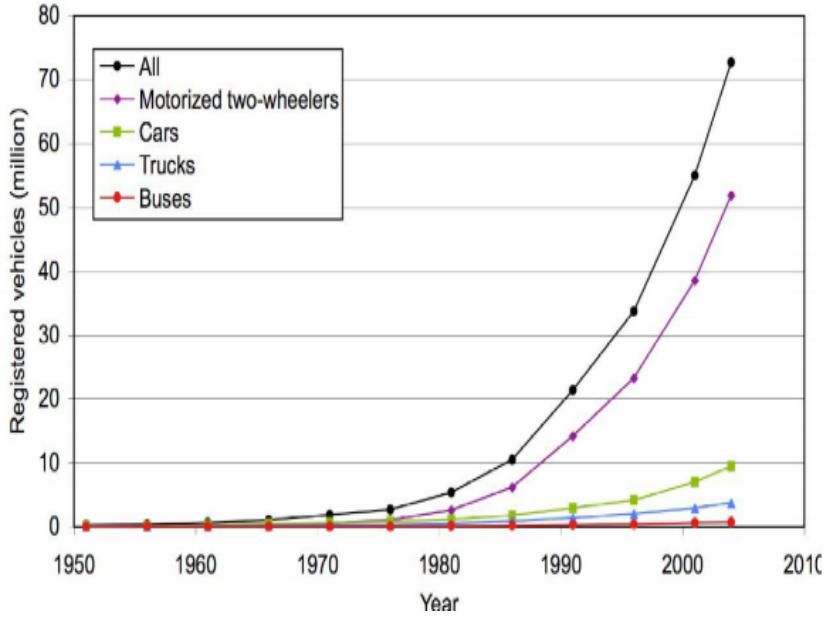

Figure 1 Registered vehicles under various categories in India

In India, the number of motor vehicles has grown from 0.3 million in 1951 to approximately 50 million in 2000. Besides substantial CO_2 emissions, significant quantities of CO, HC, NO_X, SPM and other air toxins are emitted from these motor vehicles in the atmosphere, causing serious environmental and health impacts. Like many other parts of the world, air pollution from motor vehicles is one of the most serious and rapidly growing problems in urban centers of India. **Table 1** represents the contribution of various sources of Air pollution in which contribution of vehicular source is significant.

Table 1 Contribution of various sources of Air pollution in Delhi, India

Source	1970-71	1980-81	1990-91	2000-01 (Projected)
Industrial	56%	40%	29%	20%
Vehicular	23%	42%	64%	72%
Domestic	21%	18%	7%	8%

According to various research and studies, about 70% of the total pollution is generated due to vehicular emissions. In earlier time the major factor contributing to air pollution was industrial emissions but due to development of technologies and equipment's for controlling air pollution as well as the rise in production and distribution of vehicles there is immense increase in pollution due to vehicles.

Vadodara, a growing city of Gujarat state, experiences huge concentration of vehicles at major traffic intersections due to which elevated level of pollutants are found in the vicinity which adversely affects the life of people. There is an urgent need to determine air quality and to find the possible and relevant solutions.

II. STUDY AREA AND PROBLEM IDENTIFICATION

Vadodara city is the third largest city in the state of Gujarat after Ahmedabad and Surat. As of 2011 Vadodara had a population of almost 2.2 million people. It is hub of various industries and education centers. Due to more number of vehicles on road, there is problem of traffic in peak hours in principal areas of the city. Also, due to extended halt in signals there is congestion at traffic intersections. After studying various areas of Vadodara in terms of traffic congestion, the Akota- Dandia bazaar crossing area was selected as the study area.

As the Akota- Dandia bazaar bridge connects the commercial areas of city such as VasnaBhaili and city area it faces tremendous amount of traffic. Also, this area can be representative of the other areas such as Mandvi area, Kothi char Rasta, Fatehgunj, etc. which also experiences the same amount of traffic. **Figure 2 and Figure 3** represent the densely populated vehicles at study site.

Figure 2 Traffic at Akota- Dandia bazaar crossing
Source: Self Observation

Figure 3 Traffic at Akota- Dandia bazaar crossing
Source: Self Observation

III. METHODOLOGY

Air quality monitoring was conducted using high volume sampler at the site during October 2017 in which the samples were collected through HVS and its analysis was conducted. The experiment was carried out for 8 hours. For every hour readings were noted.

Figure 4 represents collecting air quality parameter at crossing site. **Figure 5** represents the collection of Nox and Sox in HVS.

Figure 4Air Quality Monitoring at Crossing Site

Figure 5 Collection of Nox and Sox in HVS

The activated alumina balls, having good absorption property were used as filter media. A prototype of filter was prepared consisting of an iron mesh and activated alumina balls in a tin can. This assembly was fitted in the tail end of exhaust pipe of vehicles and results were obtained regarding air quality monitoring.

Figure 6 represents the prototype of the activated alumina filter. **Figure 7** represents the activated alumina balls.

Figure 6 Prototype of Activated Alumina Filter

Figure 7 Activated Alumina Balls

IV. RESULTS

Table 2 represents the value of SOx, NOx and PPM_{10} and comparison with national ambient air quality standards (42 U.S.C. 7401). From the results the value of PPM is beyond limit. The permissible limit of PPM is 100 micrograms per meter cube, where as the result obtained is 179 micrograms per meter cube. Other parameters are within permissible limit. **Figure 8** represents the graphical representation of Ambient Air Quality parameters

Table 2 Analysis of Ambient Air Quality [7]

PARAMETER	VALUE In ($\mu g/m^3$)	PERMISSIBLE LIMIT ($\mu g/m^3$)
SO_x	12.96	80
NO_x	3.77	80
PPM_{10}	179	100

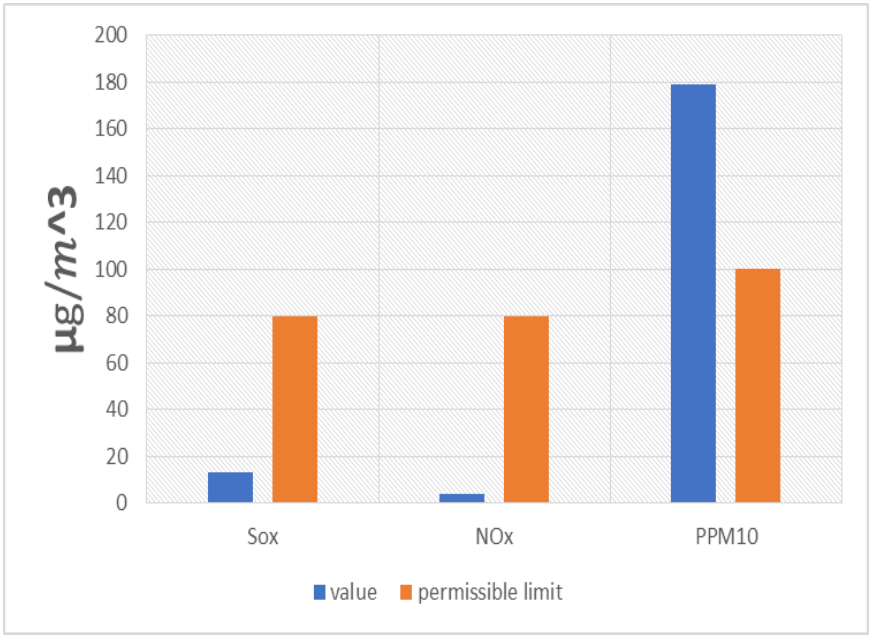

Figure 8 Graph of Analysis of Ambient Air Quality

Table 3 represents results of air quality monitoring after assembling Activated Alumina filter. Figure 9 represents the graphical representation of PUC readings.

Table 3 PUC Readings

PARAMETER	REGULATION	READING WITHOUT FILTER	READING WITH FILTER
CO	4.5	2.153	0.745
HC	9000	1080	246
CO_2	0	1.4	0
O_2	0	15.76	15.19
NO_x	0	0	0

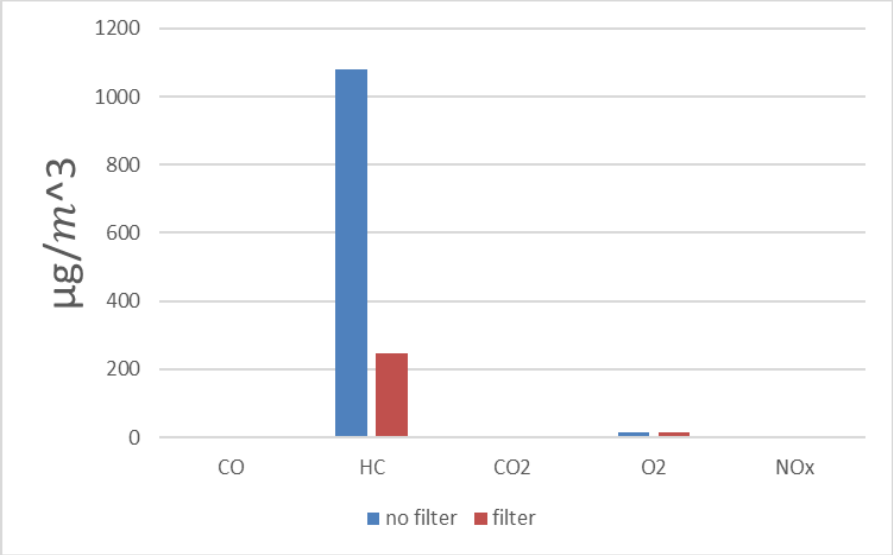

Figure 9 Graph Showing PUC Readings

V. CONCLUSION

The ambient air quality monitoring was conducted at Akota Bridge Dandia bazar area of Vadodara city which revealed that the value of SOx and NOx was within the permissible limit, whereas the result obtained for PPM_{10} was found 179 microgram per meter cube which is more than the permissible limit.

Activated alumina filter was developed which gave promising results. The value of CO and HC was considerably reduced whereas the value of CO_2 was observed zero. Hence such filter can be proved as an effective tool to reduce the vehicular air pollution. Due to less emission of carbon dioxide global warming can be reduced. Use of such filter assembly unit can be made for design of the exhaustion chamber of the vehicles. However, the analysis of performance and maintenance of the activated alumina filter to reduce concentration of pollutants at different temperature has further scope of study.

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