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Comparative study of vehicular pollution in Urban and Sub urban areas of Srinagar city, Kashmir, India

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ABSTRACT

An attempt has been made in this research work to evaluate the current status of vehicular pollution in Srinagar city, the Capital City of Jammu and Kashmir, India. The main thrust in this research work is given on the contribution of urban and sub-urban vehicular exhausts to the total City's Vehicular Pollution. Two sites were selected from each area (i.e. two from urban area and two from sub-urban), close to the road about 20ft from the center of the road. The main parameters considered for the study include SPM, settleable particulate, NOx, SO_2 and Noise level. The samples were collected between 0900-1700 hours and analysis was carried out within 24 hours. Through out the study, SPM was found much above the standards. On an average, the highest level of SPM, 720.2μg/m^3 was recorded at site-II of Athwajan and lowest 426.4μg/m^3 at Zainakadal at site-II. Overall NO_2 was found higher at Athwajan than at Zainakadal mainly due to high Traffic flow and Traffic Jams. Athwajan was found to have more pollutant level of SO_2 than Zainakadal, which may be due to more traffic flow, and large number of heavy diesel vehicles at Athwajan. Noise level at all the sites was found much above the standards. At Athwajan the maximum level was found at site-II, (111.6dB (A)). At Zainakadal noise level was found maximum at II, 102dB (A). Moreover, a negative correlation has been observed between the speed of the vehicle and emission of carbon monoxide. While as Positive Correlation has been observed between the Speed of the vehicle and Nitrogen oxide emissions. Finally the remedial measures have been suggested in order to minimize the Vehicular Pollution.

1. INTRODUCTION

Motor vehicles have been closely identified with increasing air pollution levels in urban centers of the world[11,12]. Besides substantial CO_2 emissions, significant quantities of CO, HC, NOx , 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[16,9,8]. The problem of air pollution has assumed serious proportions in some of the major metropolitan cities of India and vehicular emissions have been identified as one of the major contributors responsible for the deteriorating air quality in these urban centers[5,6]. Although recently, improvement in air quality with reference to the criteria pollutants (viz., NOX, SO_2, CO and HC) has been reported from some of the cities, but the air pollution situation in most of the cities is still far from satisfactory[6,7]. The problem has further been compounded by the concentration of large number of vehicles and comparatively high motor vehicles to population ratios in these cities[8,10]. In India, the number of motor vehicles has grown from 0.3 millions in 1951 to approximately 50 millions in 2000, of which, two wheelers (mainly driven by two stroke engines) account for 70% of the total vehicular population. Two wheelers and cars (four wheelers, excluding taxis) which mainly constitute personal mode of transportation, account for

TABLE 1: Emission from a typical and indian car

Speed (Km/h)	Hydrocarbon (ppm)	CO (%)	NOx (ppm)
Idle	3200	3.50	75
32	2825	1.39	475
48	2475	0.28	1375
64	2175	0.18	1600
80	2000	0.18	1945

approximately four-fifths of the total vehicular population[14].

The Toxic Vehicular exhausts are a source of considerable air pollution, next only to thermal power plants. The ever-increasing vehicular Traffic density posed continued threat to the ambient air quality. In India, the Central Board for prevention and control of Water Pollution has conducted a study on the vehicular emissions. The results indicate that Indian Vehicles release a much higher concentration of pollutants that the vehicle in the west[1]. The emissions from a typical and Indian car is shown in TABLE 1. Urban air pollution is of growing concern in a fast developing country like India. The unprecedented increase in the ambient air pollution levels is mainly due to recent upsurge in the number of motor vehicles in the country, which has witnessed a quantum jump from a mere 306 thousands in 1951 to 30209 thousand vehicles in 1995[4]. The automobile industry is incessantly showing further rapid upward growth trends. This, together with lack in requisite infrastructural development, in the operation of old fleets, poor vehicle maintenance, poorly maintained road conditions, age-old traffic management systems, low fuel quality, little technological advancement in the vehicle engine designs and the adoption of only adhoc policy measures, have led the situation to attain the present alarming proportions.

The concentration of gases is maximum during the summer and minimum during winters[13]. The Peak value is found during daytime. In case of SPM, the concentration level is critical during winters and minimum during summers. Turbid air in areas of dense vehicular Traffic, Pungent Polluted atmosphere, the layers of dust accumulated in air surrounding Delhi and other Metropolitan city reveal us that man should not be an a inactive silent spectator. Higher concentrations of CO are due to number of two and three wheelers passing and the slow movement of the vehicles (Thirumarran, M. et. al, 2001). If the Traffic is regulated and the road condition is improved, concentration level can be considerably reduced and can be brought with in the limits.

In India, 25% of the total energy (of which 98% comes from oil) is consumed by road sector only. Although gasoline vehicles dominate (approximately 85%) the vehicular population, the consumption of diesel is six times more than the consumption of gasoline (petrol). A gradual shift in passenger and freight movement from rail to road-based transportation has also lead to marked increase in fuel consumption by the road sector[9].

Vehicles in major metropolitan cities of India are estimated to account for 70% of CO, 50% of HC, 30%-40% of NOx , 30% of SPM and 10% of SO2 of the total pollution load of these cities, of which two third is contributed by two wheelers alone. These high level of pollutants are mainly responsible for respiratory and other air pollution related ailments including lung cancer, asthma etc which is significantly higher than the national average[2,3,4].

Several laws have been enacted in India to control vehicular pollution; however, their implementation cannot be considered satisfactory (S M Sarin et.al, 2000). Recently, the central government, various state governments and other regulatory agencies have taken several initiatives to control and reduce the vehicular emissions[2,3]. The Supreme Court of India has also played an important and active role by its landmark judgments forcing concerned agencies to take necessary actions to control the nuisance of vehicular pollution in India. Although at present, most of these vehicular pollution reduction strategies are confined to major metros only, however, they are being gradually extended to other urban centers also. However, it is still a long way before air pollution situation of these cities can be considered safe with reference to the ambient air quality guidelines specified by World Health Organization (WHO) and Central Pollution Control Board (CPCB) in India[4,5,6].

Lack of awareness among drivers, lack of controlling mechanisms adopted by the Traffic managers, lack of Public awareness on air Pollutants, idling of vehicles at traffic intersections and corrupt practices adopted by various interested parties and developments have indeed multiplied the agony of air pollution.

2. Study area

The areas for the study chosen include an urban area (Zainakadal) and a sub-urban area (Athwajan) of the Srinagar district. The Athwajan as a sub-urban area is located at about 8Km from the, main Srinagar city at 34^0 02′.31.02″ N latitude and 74^0 52′28.42″ E longitude with altitude of 5206ft from the mean sea level. Zainakadal on the other hand is located at 34^0 05'35.63"N latitude and 74^0 48' 24.67"E longitude with altitude 5210ft and is about 5Km from the main city. Athwajan has an area of about 0.92km^2 (1840 kanals) and total population of 1715, while Zainakadal has an area of 0.212km^2 (424 kanals) and population of 6942 (census, 2001).

As the National high way passes through the Athwajan and is the entry point into the city has a very high Traffic density, further, the Badamibagh cantonment and the new Bus stand further adds to the Vehicular Traffic Pressure. Zainakadal, which is in the midst of the city, has also a significant influence due to Vehicular Pollution but comparatively less than that of Athawajan. After the thorough Survey of the two areas, two sites were selected at each area for the sampling purposes. The salient features of different sites are given below.

ZK-I: It is a site at Zainakadal, located at the three-way road junction near Maharaj Gunj Police Station and the Famous Pathar masjid. At this site there is much Traffic Pressure and crossing, bus stopping, idling and even vehicular jam are usual Phenomena at the site.

ZK-II: It is situated near the new Zainakadal Bridge at the bank of river Jehlem. It has comparatively less Traffic Pressure than ZK-I and represents a general urban site.

Ath-I: It is a site at Athwajan, located at the National high way near the Jamia-masjid Athwajan and Mazar-I-Mehjoor, the famous poet of Kashmir. It represents a general road site at the high way.

Ath-II: It is situated at the three-way road crossing (Bypass) near the Delhi Public School and the Bus Stand. It has very high traffic pressure. Traffic Jams and idling of the vehicles are very common at the site. It is the entry point into the city.

3. Methodology

As the main objective of the study was to quantity the vehicular pollution, the sites were selected according to the purpose; two sites were selected from each area, close to the road about 20ft from the center of the road. The main parameters considered for the study include SPM, settleable particulate, NOx, SO_2 and Noise level. The samples were collected between 0900-1700 hours and analysis was carried out within 24 hours. The samples of SPM and gases (SO_2 and NOx) were collected for analysis.

The methods used for the analysis of the above-mentioned parameters are: -

1. Settleable particulate (Dust fall)

The dust fall was analyzed by Gravimetric method in terms of grams per meter square area per hour basis.

2. Suspended particulate matter (SPM)

SPM was sampled using GF/A Whatman filter paper, by the Gravimetric method. The collected samples were weighed using electronic balance XP-300 and calculations were made based on IS 5182, part IV in order to obtain the final concentration of the SPM.

Nitrogen dioxides (NO_2)

NO_2 was collected by bubbling air through sodium hydroxide (NaOH) absorbing solution to form a stable solution of sodium nitrite. The nitrite ion produced during sampling was determined colorimetrically by reacting the exposed absorbing reagent with phosphoric acid, sulphanilamide and N (1-naphthyl) ethylene diamine dihydrochloride (NEDA) solution and analyzed spectrophotometricaly using ELICO SL-171 spectrophotometer at 540nm. The concentration was determined from the standard curve.

4. Sulphur dioxide (SO_2)

The SO_2 present in the air was absorbed in a solu-

Composition and Density(No./h) of Traffic at Zainakadal, Srinagar, 2007

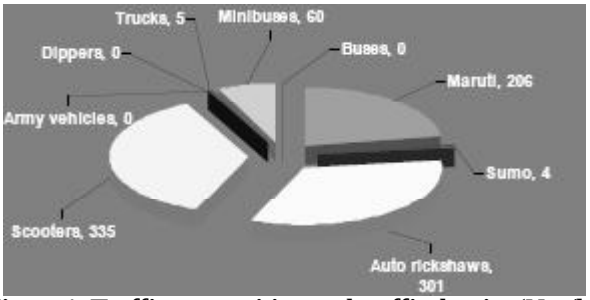


Figure 1: Traffic composition and traffic density (No. /h) at Zainakadal, Srinagar, 2007

Composition and Density(No./h) of Traffic at Athwajan, Srinagar, 2007

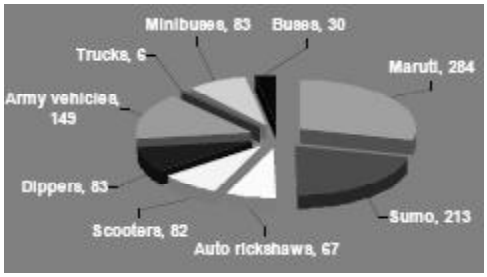
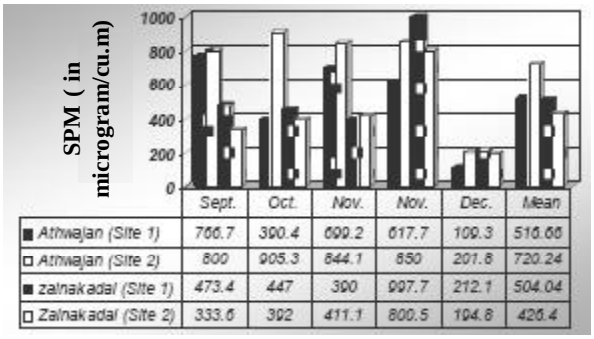
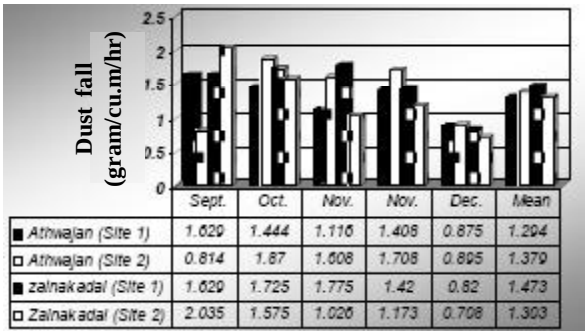


Figure 2: Traffic composition and traffic density (No. /h) at Athwajan, Srinagar, 2007



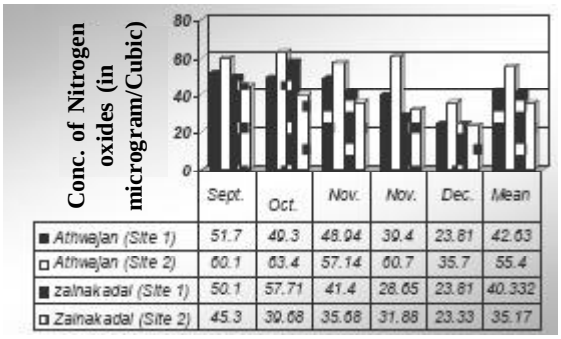
	Sept.	Oct.	Nov.	Nov.	Dec.	Mean
Athwajan (Site 1)	766.7	390.4	699.2	617.7	109.3	516.66
Athwajan (Site 2)	600	905.3	844.1	650	201.8	720.24
zainakadal (Site 1)	473.4	447	390	997.7	212.1	504.04
Zainakadal (Site 2)	333.6	302	411.1	800.5	104.8	426.4

Figure 3: Concentration of SPM (in μg/m³) at Zainakadal and Athwajan, Srinagar, 2007



	Sept.	Oct.	Nov.	Nov.	Dec.	Mean
Athwajan (Site 1)	1.629	1.444	1.116	1.408	0.875	1.294
Athwajan (Site 2)	0.814	1.87	1.608	1.708	0.895	1.379
zainakadal (Site 1)	1.629	1.725	1.775	1.42	0.82	1.473
Zainakadal (Site 2)	2.035	1.575	1.026	1.173	0.708	1.303

Figure 4: Dust fall (in g/m³/hr) at Zainakadal and Athwajan, Srinagar, 2007



	Sept.	Oct.	Nov.	Nov.	Dec.	Mean
Athwajan (Site 1)	51.7	49.3	48.94	39.4	23.81	42.63
Athwajan (Site 2)	60.1	63.4	57.14	60.7	35.7	55.4
zainakadal (Site 1)	50.1	57.71	41.4	28.65	23.81	40.332
Zainakadal (Site 2)	45.3	39.68	35.68	31.88	23.33	35.17

Figure 5: Conc. of NO_2 (in μg/m³) at Zainakadal and Athwajan, Srinagar, 2007

tion of sodium tetrachloromercurate. The solution was then reacted with formaldehyde and pararosaniline hydrochloride, a violet-red complex is formed which was measured spectrophotometrically at 560nm and SO_2 concentration was deduced from the curve.

5. Noise level

Noise level was measured by using Digital Sound level meter AZ 8921 (30-130 dB) in decibels (dB).

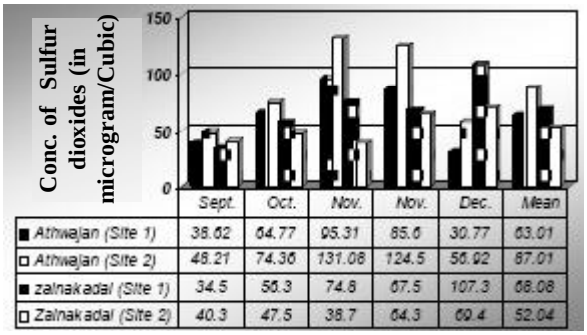
4. RESULTS AND DISCUSSION

The traffic density at each site was noted for 1 hour during different times of the day to get an average Traffic flow. Figure 1 and figure 2 shows the composition of vehicles and their density at Zainakadal (Urban) and Athwajan (Sub-Urban) areas respectively. At Athwajan Maruti, Sumo and Army vehicles are dominating; Dipper, Minibuses, Buses and other heavy vehicles have also a significant contribution in addition to two wheelers and 3-wheelers. On the other hand, at Zainakadal two wheelers and 3-wheelers are highest in density, plus Martui also contributing well.

Through out the study, SPM was found much above the standards (Industrial, 500μg/m³, commercial 200μg/m³). On an average, the highest level of SPM 720.2μg/m³ was recorded at site-II at Athwajan and lowest 426.4μg/m³ at Zainakadal at site-II (Figure 3)The higher levels of SPM are the indications of poor road conditions, narrow roads and increasing Traffic and its uncontrolled regulation.

Dust fall at Athwajan was found higher at site-II (1.379 g/m³/hr) than at site-I (1.294g/m³/hr). At Zainakadal it was 1.473 g/m³/hr at site-I, and 1.3031 g/m³/hr at Site- II. During December lower readings were recorded due to rainfall (Figure 4).

Nitrogen oxides appear in engine exhausts at concentrations ranging from <30ppm during Idling to >1000 ppm during cruising and acceleration. These oxides play an important role in smog formation and acid rains. The concentration of NO_2 at all the sites was found within the limits as specified by CPCV. The highest level of NO_2 was observed at site-II (Mean-55.40μg/m³) followed by site-I at Athwajan (42.63μg/m³). At Zainakadal Lower level of NO_2 was found at site-II (35.17μg/m³) and highest at site-I (mean 44.332μg/



	Sept.	Oct.	Nov.	Nov.	Dec.	Mean
Athwajan (Site 1)	38.62	64.77	95.31	85.6	30.77	63.01
Athwajan (Site 2)	46.21	74.36	131.08	124.5	56.92	87.01
zainakadal (Site 1)	34.5	56.3	74.6	67.5	107.3	68.08
Zainakadal (Site 2)	40.3	47.5	38.7	64.3	69.4	52.04

Figure 6: Conc. of SO_2 (in μg/m³) at Zainakadal and Athwajan, Srinagar, 2007

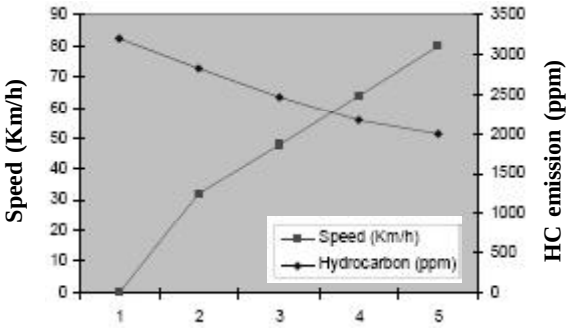


Figure 7: Correlation between speed and emission of HC

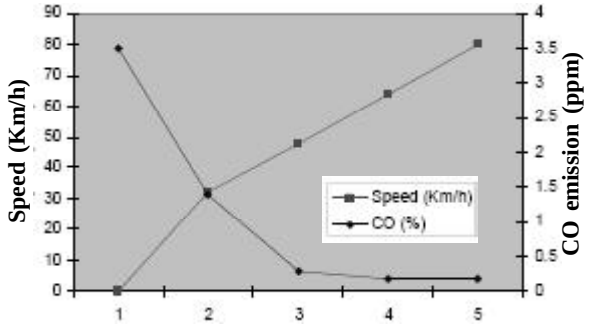


Figure 8: Correlation between speed and carbon monoxide emissions

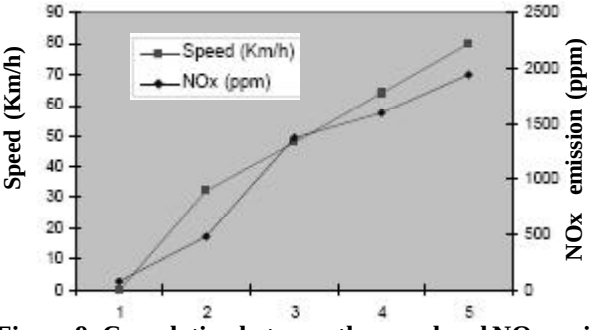


Figure 9: Correlation between the speed and NOx emissions

m³) (Figure 5). Overall NO_2 is higher at Athwajan than at Zainakadal mainly due to high Traffic flow and Traffic Jams.

SO_2 has been one of the common gaseous pollutant, released mainly from combustion of petroleum and coal. SO_2 combines with moisture to form sulphuric acid which may precipitate as acid rain, injurious to human health, plant life and cultural assets.

From the study, SO_2 level is highest at site-II of Athwajan i.e., 87.01μg/m³. At Zainakadal Site-I has higher SO_2 level 68.08 μg/m³. Through out the study, the highest level was observed at site-II during November i.e., 124.50μg/m³ that is above the standard (Figure 6). Although most of the times the levels were below the standards but sometimes it has crossed the limits. Athwajan has more pollutant level of SO_2 than Zainakadal, which may be due to more traffic flow, and large number of heavy diesel vehicles at Athwajan.

Noise level at all the sites was found much above the standards. At Athwajan the maximum level was found at site-II, i.e., 111.6dB (A) and minimum level at site-II was 108.7dB(A). At site I, max and min. levels are 61.4 db(A) and, 71.2dB(A) respectively. At Zainakadal noise level was maximum at II, 102dB(A) and minimum at site-I 53.7dB(A) TABLE 2. The Noise level is the direct indication of traffic density.

From the research study Negative Correlation has been found between the Speed of the vehicle and emission of Hydrocarbons (Figure 7). Negative Correlation has also been observed between the Speed of the vehicle and emission of Carbon monoxide (Figure 8). While as Positive Correlation has been observed between the Speed of the vehicle and Nitrogen oxide emissions (Figure 9)

5. Remedial measures

Improved design of engines, efficient and alternate fuels, application of pollutant control devices such as catalytic oxidation reactor and thermal oxidation reactor, maintenance and widening of roads, proper driving, proper traffic planning and regulations, awareness among drivers and public, curbing traffic jams and idling at intersections could help in reducing the menace

TABLE 2: Noise level dB (A) of Zainakadal and Athwajan, Srinagar 2007

	Athwajan		Zainakadal	
	Site 1	Site II	Site 1	Site II
Minimum	61.4	71.2	53.7	92.8
Maximum	108.7	111.6	57.2	102

caused by Vehicular Pollution.

Use of biofuels can help in reducing the pollution. Compressed Natural Gas (CNG) has a promising future as an automobile fuel being economical and minimizes the pollutants released into the atmosphere. Maintaining a green belt of trees along the road could help in absorbing and filtering the pollutants. In short it may be concluded that the vehicular pollution can be minimized by the integrated application of all these measures so as to maintain the quality of air for human health and other living creatures for sustenance of life.

6. CONCLUSION

Traffic is the major source of air pollution, which is increasing at an alarming rate. The unrestricted increase in number of vehicles, deficiency and poor condition of roads, adultered fuels, maintenance of vehicle and driving activities, type of vehicles and poor technology have further complicated the problem of vehicular pollution. From the study of the two areas, it is clear that the two areas are quite different in terms of their Traffic composition. At Zainakadal two wheeler and three-wheelers (Scooters and Autoriskshaws) are present in large numbers and hence the main polluters. At Zainakadal about more than 90% of the vehicles are petrol driven. At Athwajan, the composition is much more heterogeneous and four wheelers are significantly large in number. Diesel driven vehicles is more dominant at Athwajan where as petrol driven two and three wheelers are lesser than at Zainakadal.

In Athwajan at site-II, the pollution level was found higher, than all other sites. This is possibly due to high pressure of Traffic flow at the crossing near Delhi Public School. The newly established Bus Stand and Army vehicles are responsible for the high pollution level. Traffic jams, due to daily army convey, intensive traffic activities due to Bus Stand and road construction and widening are responsible for higher values of SPM, Particulate matter, smoke, NO_2, SO_2 and other pollutants. Higher value of SO_2 at Athwajan are reflecting due to more diesel vehicles as diesel contains 3% of sulphur content which is higher than petrol which contain 1% and SO_2 emission are higher from diesel vehicles. More smoke is mainly contributed due to low speed and traffic jams at the crossing of Athwajan.

At Site-I of Athwajan, Pollutant level is slightly lesser than at site-II as the site is located near the straight road, with no crossing or Bus stop and away from the bus stand.

In Zainakadal, at site-I, which is located at the 3-way crossing and has more traffic flow, pollution level is higher than at site-II which is on a straight road with low traffic flow. The higher levels of NOx, SO_2 SPM and smoke are due to two and three wheelers which are powered by two stroke spark-ignition engines, which are most serious offenders from air pollution point of view. The higher levels of smoke are also due to two stroke petrol engines which release about 30-100 times larger amount of unburnt hydrocarbons and more carbon monoxide than the 4 stroke or diesel engines.

On the whole, it is ascertained that the over all pollution level is higher at Athwajan than Zainakadal mainly due to high traffic activity, as National Highway passes through the Athwajan and the Badamibagh contonment and the Bus Stand. However the difference is not too much significant despite of these factors, this is because at Zainakadal two and three wheelers, operated by 2 stroke spark ignition engine on one hand and other petrol driven vehicles on the other hand. These two factors contribute for more pollution and thus over coming the effect of high traffic density at Athwajan giving a slight difference. Compression ignition engines, that propel trucks, dippers, buses, sumo and jeeps have lower concentration of Pollutant emission than spark ignition engines, although their exhaust is responsible for higher particulate emission and has an offensive odour level .

In conclusion, it may be pointed out that vehicular pollution is increasing at a very high rate and degrades the air quality in the urban and sub-urban areas and is of serious concern in the modern cities.

7. REFERENCES

[1] S.K.Agarwal; Automobile Pollution (Concerns, priorities and challenges) Ashish Publishing House 8/81, Punjabi Bagh, New Delhi-110026, **(1991)**.

[2] B.Sengupta, R.C.Saxena, N.Badhwar; Indian Journal of Air Pollution Control, **1**, 1-39 **(2001)**.

[3] B.Sengupta; 'Steps Taken to Control Vehicular Pollution in India', Paper Presented in International Workshop Organized by SIAM, December 4-5,

New Delhi, **(2001)**.

[4] CPCB; 'Benzene in Air and its Effects on Human Health. Parivesh Newsletter. Central Pollution Control Board', Ministry of Environment and Forests, New Delhi, Government of India, **(2002)**.

[5] CPCB; 'Auto Emissions, Parivesh Newsletter, Central Pollution Control Board', Ministry of Environment and Forests, Government of India, **(1999)**.

[6] CPCB; 'Air Quality Status and Trends in India, National Ambient Air Quality Monitoring Series, NAAQMS/14/1999-2000, Central Pollution Control Board', Ministry of Environment and Forests, New Delhi, Government of India, **(2000)**.

[7] CPCB; 'Air Quality in Delhi **(1989-2000)** National Ambient Air Quality Monitoring Series, NAAQMS/17/2000-2001, Central Pollution Control Board.' Ministry of Environment and Forests, New Delhi, Government of India, **(2001)**.

[8] CRRI; 'Evaluation of Emission Characteristics and Compliance of Emission Standards of in-use Petrol Driven Vehicles and Critical Appraisal of Pollution Checking System in Delhi', Technical Report, Central Road Research Institute, New Delhi, **(1998)**.

[9] CSE; 'Slow Murder', Centre for Science and Environment, New Delhi, **(1996)**.

[10] CSE; 'A Special Presentation by Centre for Science and Environment to the Committee on Auto Fuel Policy (Mashelkar Committee)', New Delhi, **(2001)**.

[11] D.Mage, G.Ozolins, P.Peterson, A.Webster, R. Orthofer, R.Vandeweerd, R.Gwyane; Atmospheric Environment, **30(5)**, 681-686 **(1996)**.

[12] H Mayer; Atmospheric Environment, **33**, 4029-4037 **(1999)**.

[13] C.P.Johathan, K.G.Ojha; Evaluation of effects on ambient air quality at I.T.O. Residential area due to vehicular pollutant, New Delhi, India. Deptt. of Pure and Applied Chemistry M.S.D. University Ajmar India, **(2003)**.

[14] N.Sharma, A.Singh, A.Shukla, M.Sarin; Recent Initiative to Control Vehicular Emissions and its Impact on the Air Quality of Delhi.' Proceedings of the Intemational Seminar Cum Workshop on Environment Issues of Industrial Infrastructure Development, Xavier Institute of Management, Bhubneshwar, **16-18**, 1-13 **(2000)**.

[15] S.M.Sarin, N.Sharma, K.Sharma, A.Singh; 'An Overview of Vehicular Emission Legislations in India', Indian Highways, **27(12)**, 5-20 **(1999-2000)**.

[16] UNEP/WHO; 'Air Pollution in Mega Cities of World', UNEP and WHO Publication, Oxford, UK, Blackwell, **(1992)**.