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Assessment of Vehicular Air Pollution in Kota City, Rajasthan

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Abstract: Vehicle emissions are responsible for about two third of air pollution in urban areas. The main pollutants emitted by vehicles include carbon monoxide, oxides of nitrogen and sulphur, hydrocarbon, lead, ozone and suspended particulate matter. These pollutants have harmful effects on human health & ecology. Poor air quality increases respiratory disorders like asthma & bronchitis and increases the risk of life-threatening diseases like cancer. In India, the impact of pollution from vehicles is increasing day by day due to rapid increase in population and modernization. Impact of vehicular pollution is more in cities due to urbanization. Kota is one of the fastest developing cities of Rajasthan having more than 65,0000 registered vehicles that shows large number of vehicles and associated impacts of emission through vehicles on polluting air. To study the vehicular pollution in Kota city, high volume air sampler is used for monitoring the air parameters in terms of SPM, SO_2 and NO_X and these measured parameters have been compared with the national ambient air quality standards issued by the Central Pollution Control Board of India.

Keywords: Air Pollution, Urbanization, Suspended Particulate Matter, Sulphur dioxide, Oxides of Nitrogen.

I. INTRODUCTION

Most of the Indian Cities are experiencing rapid urbanization and the majority of the people are expected to be living in cities within a period of next two decades. The rapid urbanization in India has also resulted in a tremendous increase in the number of motor vehicles. Number of vehicles has doubled in some cities of India in the last decade. Top six cities in India with highest vehicle population are Delhi, Chennai, Hyderabad, Pune, Mumbai and Kolkata. At global level, the major consumption of oil is in transport sector that shows that vehicles are the only major source of air pollution and India is also suffering from vehicle related pollution problems.

The quality of air has become very poor in India. The cause of high emissions in Kota is vehicles and industries along with conditions like inversions and stagnation which is restricting the dispersion of pollutants into the atmosphere. The sources of pollutants are combustion of fossil fuels in motor vehicles, industrial processes and high dust levels due to unpaved roads and long-range transport from surrounding barren landscapes. The growth of vehicles in India is a major concern to increase the vehicular emission and deterioration of air through pollutants released by these vehicles.

Vehicle emissions are responsible for about two third of air pollution in urban areas. The main pollutants emitted by vehicles include carbon monoxide, oxides of nitrogen and sulphur, hydrocarbon, lead, ozone and suspended particulate matter. These pollutants have harmful effects on human health and ecology. Poor air quality increases respiratory disorders like asthma and bronchitis and increases the risk of life-threatening diseases like cancer.

II. STUDY AREA

Kota is a city located in the south east of northern India in Rajasthan state. It is located at around 250 kilometres from Jaipur, the capital of Rajasthan. Kota city is situated on the banks of the Chambal River, the longest river of Rajasthan. It is the third most populated city of Rajasthan after Jaipur and Jodhpur and 46th most populated city of India. Kota is the fourth city in Rajasthan having highest number of registered vehicles after Jaipur, Jodhpur and Udaipur.

Kota is a rapidly developing city with respect to demography, migration, transportation, development in industrial and education sectors for the last two decades. The intensity, quantity, and frequency of both urban and suburban as well as the to and fro movement with other cities are the factors responsible for increasing transportation problems in Kota. The dependency of population on transportation systems is quite high. Kota is one of the cities having around 6.5 lakh registered vehicles apart from other vehicles of neighbouring cities and towns.

The following ten major roads of Kota were selected for the study purpose: Rawatbhata road, Chambal Garden road, C.A.D. road, Mahaveer Nagar road, Jhalawar road, Bhamashah Mandi road, Gumanpura (Kotri) road, D.C.M. road, Kishore Sagar Talav road and Nayapura road.

III. STATUS OF VEHICULAR POLLUTION IN KOTA

Kota is well connected with neighbouring districts and major cities outside the state through National and State highways such as National highway No.12 (Jaipur to

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Jabalpur) and National Highway No.76 passing through Kota and State Highway (Kota to Lalsot). National Highway No.76 is a part of East-West Corridor. The total road length in Kota is 2052 km and this large road length proves the importance to study vehicular pollution in Kota and as such there is an urgent need to address the interrelated problems and obstacles experienced by the public of Kota regarding air pollution through vehicles.

The vehicles with poor environmental quality continue to grow in multiple ratios. The traffic congestion resulting from transportation contributes even greater to the deteriorating environment in Kota. Congestion problem is mostly seen at Nayapura road, Aerodrome road, Jhalawar road and Gumanpura road. During evening, condition becomes worst at these roads of Kota. In the last decade, increase in average motor vehicles in Rajasthan has gone up by 9.75 percent every year. The tremendous increase of vehicles affect the ambient air quality of Kota and public health quality whether they are pedestrian, commuters or local residents of Kota.

IV. METHODOLOGY

In India, the impact of pollution from vehicles is increasing day by day due to rapid increase in population and modernization. Impact of vehicle pollution is more in cities due to urbanization. Kota is the fastest developing city of Rajasthan having more than 6.5 lakh registered vehicles that shows large number of vehicles and associated impacts of emission through vehicles on the environment.

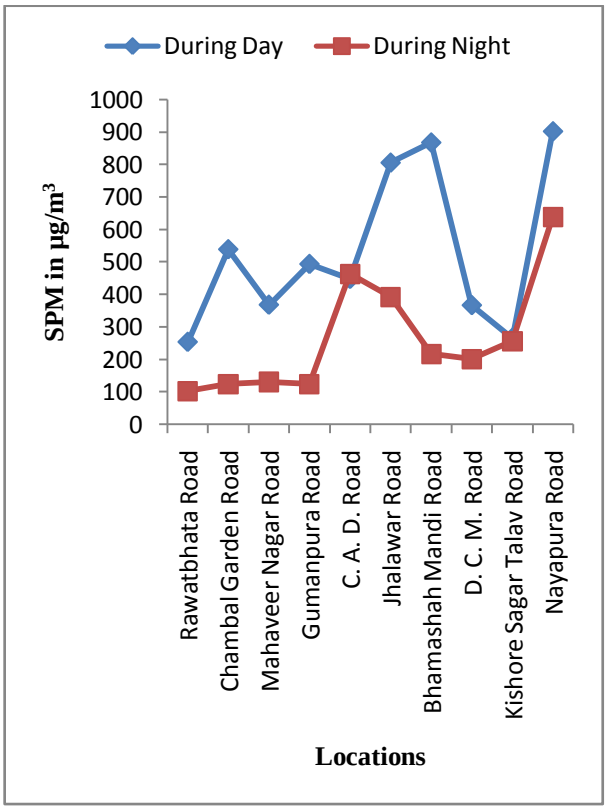
To study the vehicular pollution in Kota, a high volume air sampler was used for monitoring the air quality at ten locations during day and night for a period of 8-hours, along the major roads of Kota and parameters like SPM, SO_2 and NO_X have been worked out as per the standard methods.

FIGURE 1: High Volume Air Sampler used for monitoring air parameters (SPM, SO_2 and NO_X)

V. RESULTS AND DISCUSSION

During the study, monitoring of air along the major roads of Kota city was performed at 10 locations. Observations were taken during day and night to get the most precise results. Monitoring was carried out from the month of August to November 2015. The duration for monitoring was kept as 8-Hours. Pollutants analysed from onsite monitoring were SPM, SO_2 and NO_X. The following graphs show the results obtained.

SUSPENDED PARTICULATE MATTER (SPM)



GRAPH 1: Levels of SPM at various locations during day and night time

The GRAPH 1 shows that except Kishore Sagar Talav Road and C.A.D. Road, the concentration of SPM at all other locations tremendously increase from night to day. It clearly indicates the impact of vehicular emissions during day time. At Kishore Sagar, there is a ban on vehicles from 5 p.m. to 11 p.m. and it is also surrounded by the biggest park of Kota which results in very less rise of SPM in day as compared to night while at C.A.D., the major source of SPM is the vehicles during day and at night, the Kota Thermal Power Station (KTPS) situated near C.A.D. Road, releases coal dust and flue gases from its stacks and hence the level of SPM is also high during night.

During nights, the lowest concentration of SPM is at Rawatbhata Road due to very less vehicles on this road as it is the exterior end of Kota city and only the vehicles moving to the Rawatbhata side are responsible for SPM in night, while the highest concentration of SPM is at Nayapura Road in night due to heavy vehicle load on it. This road serves as an entrance road to Kota city connected to National Highways (NH-12 and NH-76) and due to congestion of the area; the dispersion of pollutants

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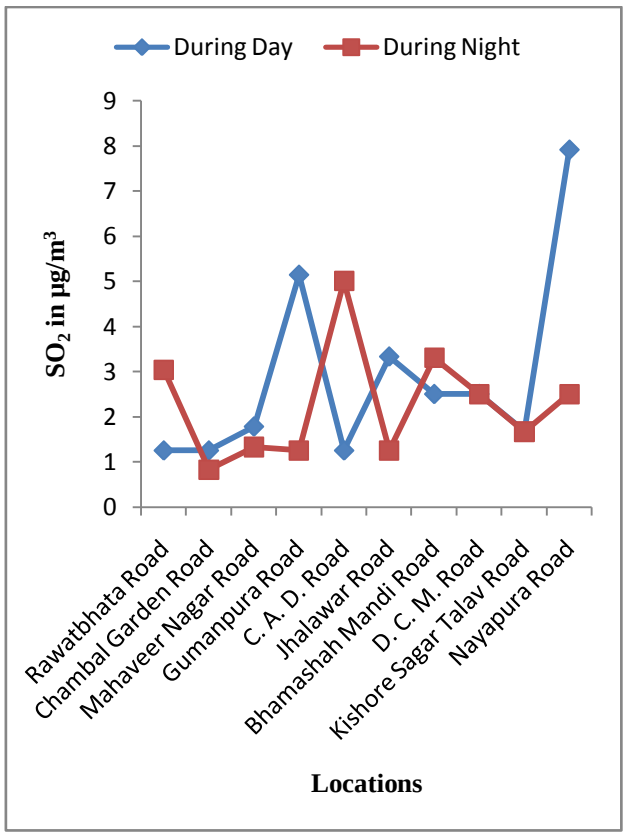
is not possible that increases the SPM level sharply at Nayapura.

SULPHUR DIOXIDE (SO_2)



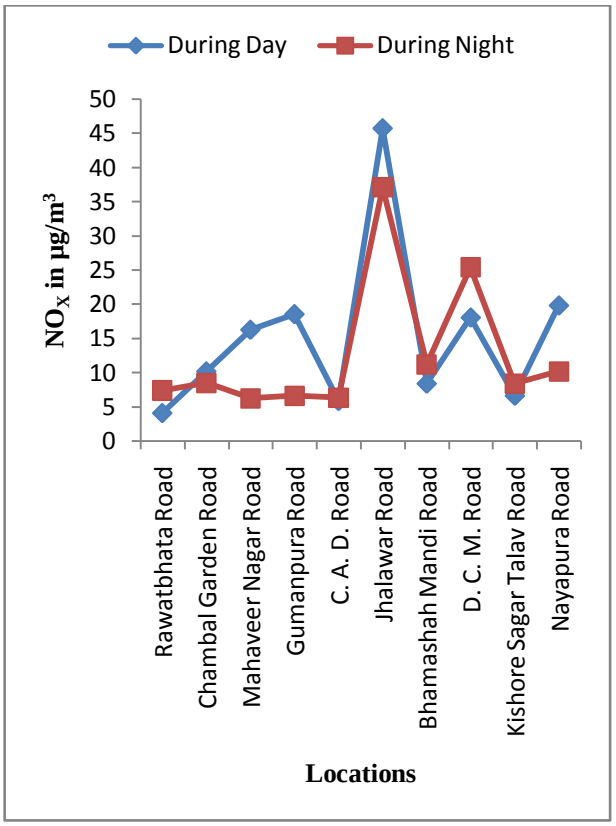
GRAPH 2: Levels of SO_2 at various locations during day and night time

The concentration of SO_2 increases with increase in vehicle density during day, however at five locations; the concentration of SO_2 in night is more than the day or nearly the same. Two locations Jhalawar Road and Bhamashah Mandi Road have more SO_2 in night as the diesel driven vehicles are the main source of pollution during night and due to restriction of heavy vehicles during day time in city, SO_2 concentration during day is less as compared to night at these two locations. Jhalawar Road is exterior to city area; and major source of SO_2 during night is the heavy vehicles.

At Kishore Sagar Talav, the concentration of SO_2 during night is nearly same because it has lots of dispersive area due to nearby park and lake along with ban on vehicles during evening hours. At Bhamashah Mandi Road, concentration of SO_2 is more in night due to trucks and heavy vehicles moving for loading and unloading of grains. It also consists of various types of storage godowns and small scale industries such as stone crushing, grading industries, agriculture utility equipment industries, chemical industries etc.

The concentration of SO_2 is within limit as per the standards having highest concentration of 5µg/m^3 during night at Jhalawar Road and lowest 0.83µg/m^3 at Chambal Garden Road while highest concentration of SO_2 during day is 7.91µg/m^3 at Nayapura Road and lowest 1.25µg/m^3 at CAD Road.

OXIDES OF NITROGEN (NO_X)



GRAPH 3: Levels of NO_X at various locations during day and night time

Concentration of NO_X is much higher than SO_2 concentration at each location which shows increase in vehicle pollution in Kota city and acts as a major pollutant source of air pollution in Kota with respect to other sources of pollution such as power plant and various types of industries. NO_X is mainly emitted from vehicles and sharp rise in NO_X with respect to SO_2 shows that vehicular emission in Kota is deteriorating air quality of Kota.

The highest concentration of NO_X is found at Jhalawar Road during day and night while the lowest concentration is found at Mahaveer Nagar Road as this area is the educational area of Kota. Most of the coaching students live here and they rarely use vehicles during night to move in this region. The NO_X concentration ranges from 45.73 to 6.23µg/m^3 during day with highest at Jhalawar Road and lowest at Mahaveer Nagar Road.
The NO_X concentration ranges from 37.09 to 5.84µg/m^3during night with highest at Jhalawar Road and lowest at C.A.D. Road. Highest concentration of NO_X during day and night at Jhalawar Road is due to both heavy and light vehicles but heavy vehicles are more dominating during night.

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TABLE I Summary of Results obtained from Monitoring of Air Quality through High Volume Air Sampler (All parameters are in μg/m^3)

S. No.	Location	Status	SPM	SO_2	NO_X
1	Rawatbhata Road	Night	103.36	3.03	7.39
		Day	253.99	1.25	4.07
2	Chambal Garden Road	Night	124.50	0.83	8.46
		Day	539.40	1.25	10.16
3	Mahaveer Nagar Road	Night	131.79	1.33	6.23
		Day	368.51	1.78	16.26
4	Gumanpura Road	Night	125.00	1.25	6.60
		Day	494.09	5.14	18.54
5	C.A.D. Road	Night	464.06	1.25	6.35
		Day	448.00	1.25	5.84
6	Jhalawar Road	Night	392.27	5.0	37.09
		Day	806.25	3.33	45.73
7	Bhamashah Mandi Road	Night	217.30	3.30	11.18
		Day	868.33	2.50	8.38
8	D.C.M. Road	Night	201.12	2.50	25.41
		Day	367.16	2.50	18.04
9	Kishore Sagar Talav Road	Night	257.11	1.67	8.38
		Day	266.66	1.67	6.61
10	Nayapura Road	Night	639.20	2.50	10.16
		Day	902.84	7.91	19.81

TABLE II National Ambient Air Quality Standards (NAAQS) as per the Central Pollution Control Board of India

S. N.	Pollutant	Time Weighted Average	Concentration in Ambient Air (μg/m^3)		
			Industrial Area	Residential, Rural and other Areas	Sensitive Area
1	SPM	Annual	360	140	70
		24 hours	500	200	100
2	SO_2	Annual	80	60	15
		24 hours	120	80	30
3	NO_X	Annual	80	60	15
		24 hours	120	80	30

As per the guidelines issued by the Central Pollution Control Board of India, the 24 hourly/8 hourly values of parameters i.e. SPM, SO_2 and NO_X should be met 98% of the time in a year.

VI. CONCLUSION

An attempt has been made in this study to monitor air quality on major roads of Kota city. Sampling stations were setup at ten locations and monitoring was carried out during day and night for a period of 8-hours with the help of high volume air sampler for three parameters SPM, SO_2 and NO_X. Based on observations, it can be concluded that during day, SPM concentration in Kota city is too high with values ranging from 254μg/m^3 to 903μg/m^3 against the standard limit of 200 μg/m^3 for residential areas; NO_X concentration ranges from 4.07μg/m^3 to 45.73μg/m^3 and SO_2 concentration ranges from 1.25μg/m^3 to 7.91μg/m^3. During night, SPM concentration ranges from 103μg/m^3 to 639μg/m^3, NO_X concentration ranges from 6.23μg/m^3 to 37.09μg/m^3 and SO_2 concentration ranges from 0.83μg/m^3 to 5μg/m^3. Hence, the high values of SPM, SO2 and NOX indicates that the ambient air quality of Kota is not suitable for the residents and therefore corrective and preventive measures need to be taken at the earliest.

VII. SUGGESTIONS

Looking to increased vehicular pollution across India and Kota and its negative impact on the air quality, following suggestion may help to reduce vehicular air pollution.

- Ban on diesel vehicles of more than 20 years life and implementing strict rule for purchase of new vehicles
- Car pooling and sharing of taxis by office employees
- Sharing of cycles' scheme in institutes and colleges
- Use of CNG, LNG, LPG, Ethanol, Hybrid electric, Plug-in Hybrid electric, Battery electric, Hydrogen fuel cell, Dual fuel or Flexible fuel techniques
- Use of catalytic convertor techniques in vehicles as they oxidize CO, HC and NO_X into CO_2 and water
- Driving at steady speed (~80km/hours) emits lowest while driving at higher speed (>110 km/hours) dramatically increase the emission rate
- Growing plants and trees along the road sides may reduce the concentration of pollutants in the air

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