Biospectra : Vol. 12(2), September, 2017, pp.47-50
An International Biannual Refereed Journal of Life Sciences

13(AS).
Animal Science

ISSN : 0973-7057

A brief study on gaseous pollutants (NOx and SOx) in ambient air in Ranchi City

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Received : 18th June, 2017; Revised : 15th July, 2017

Abstract: Air pollution is a serious problem in cities. Rapid industrialization and urbanization causes increased concentration of sulfur oxides and nitrogen oxides. In the rainy season the concentration of these pollutants is at the minimum level.

Keywords : air pollution, oxides of nitrogen and sulfur, concentration, mobile sources

INTRODUCTION

The quality of ambient air is deteriorating because of the rapid industrialization and urbanization. Manmade and natural sources of emissions have created toxic substances, which pollute the air. Countries all over the world have set stringent ambient air quality objectives, guidelines and regulations in order to protect both the general population and those thought to be most at risk e.g., children, the elderly, and those with pre-existing cardio-respiratory disease. Ambient air pollution levels have declined in many developed and developing countries because of these regulatory efforts.[1,2]

Criteria air pollutants including CO, NOx, SO_2 & PM are the quality parameters of ambient air. The main sources of nitrogen oxides NOx (NO + NO_2) is the combustion process. Mobile sources are responsible for an important part of total NOx emissions. Sulphur oxides are produced by burning of coal, vehicle emissions and emissions from oil/gas fields and refineries.[3,4] They are mainly emitted from stationary combustion sources.

The dispersion and transport of pollutants in the atmosphere is of prime concern for the environmentalists. The dispersion is affected by various meteorological parameters, such as wind speed, direction, temperature, humidity, etc.[5]

In the present study an attempt has been made to assess the prevailing concentration of SOx and NOx in the rapidly growing of Ranchi city. The motivation for doing this work emanates from the fact that as per the National Ambient Air Quality Monitoring Data, the SOx and NOx levels in most of the cities in India have been found to be on the rise and in many cities their concentration is above the permissible limit.

STUDY AREA

Ranchi city, the capital of Jharkhand State lies at 23°22'N latitude 85°20'E longitude. Its municipal area is 175.12 square kilometers, and its average elevation is 651 m above sea level. Three specific zone of Ranchi city which were chosen for the present study represent three regions of the city: commercial zone (Kantatoli), residential zone (Ashok Nagar), and industrial zone (Tupudana).

MATERIALS AND METHOD

The sampling of ambient air quality was done simultaneously in each month between December 2009 and November 2011 at the three select sampling sites. The respirable dust sampler (RDS) fitted with gaseous

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sampling attachment (APM 411) was used for monitoring of SOx and NOx values. SOx and NOx concentration was observed continuously for 8 hours in a day. The sampling for SOx and NOx was done using absorbing reagent. On site meteorological data was gathered by using Wind Monitor (Envirotech WM251).

The meteorological data showed that during the year 2009-10, the average wind in the winter months (December- March) was 3.45 m/s, in summer or pre-monsoon (April-June) it was 6.53 m/s , in rainy season (July –September) 5.83 m/s, and in the post-monsoon or autumn period (October- November) it was 3.9 m/s. The corresponding figures for the year 2010-11 are 4.0 m/s, 5.37 m/s, 5.13 m/s, and 4.1 m/s, respectively. Around 80 percent of precipitation was received during the months of June, July, August, and September. During the post monsoon period the precipitation was around 9 percent, while it was 11 percent between the months of January and May. The average temperature in the first experimental season ranged between 15.6 and 32.0^{o}C; and between 15.5 and 29.5^{o}C in the second sampling year.

The average relative humidity ranged between 24.1 and 84.0% during the first sampling year (December 2009 to November 2010) and between 36.5 and 88.3% during the second sampling year (December 2010 to November 2011).

RESULT

The maximum concentration of sulphur dioxide occurs just during the winter months which can be attributed to low ambient air temperature. The SOx values during the pre-monsoon period (April to June) in the commercial zone (CZ), residential zone (RZ), and industrial zone (IZ) was found to be between 27.53 – 28.84 μg/m^3, 10.60- 11.81μg/m^3, and 20.41-27.77 μg/m^3, respectively in the year 2009-2010 (December to November), and 25.67-28.25μg/m^3, 7.27-25.26 μg/m^3, and 25.67-28.25μg/m3, respectively in the year 2010-2011 (December to November).The post monsoon period also shows increase in SOx values which has also been studied in other localities. In the post-monsoon period (October to November), SOx values recorded in the CZ, RZ, and IZ are between 27.84-28.04μg/m^3, 13.92-15.30μg/m^3, and 30.44-30.85 μg/m^3, respectively in the year 2009-2010, and 27.84-28.04μg/m^3, 12.83-14.36 μg/m^3, and 27.57-29.9 μg/m^3, respectively in the year 2010-2011. During the monsoon period the amount of SOx in the ambient air decreases which is in accordance with the theoretical behaviour of SOx. During the winter season (December to March) the value of SOx in the CZ, RZ, and IZ was between 25.70-27.62 μg/m^3, 6.64-16.09μg/m^3, and 20.92-33.85 μg/m^3, respectively in the year 2009-2010, and 25.24-30.69μg/m^3, 11.87-20.18 μg/m^3, and 17.14-33.87μg/m3, respectively in the year 2010-2011. The data shows that SOx pollution in the city is more because of domestic activities than the industrial activities. The SOx shows an increasing trend in concentration from the month of October. The monsoon rains lashes Ranchi city from the early part of June and continues till the month of September. The SOx concentration during the monsoon period (July to September) of 2009-2010 in the CZ, RZ, and IZ was found to be between 26.31 – 28.35μg/m^3, 11.87– 12.33 μg/m^3, and 22.97-27.77μg/m^3, respectively. During the year 2010-2011, the corresponding values were between 14.34-21.48μg/m3, 10.39-21.2μg/m^3, and 12.97-25.04μg/m^3, respectively. The more or less consistent values of SOx values throughout the year indicate that either the dispersal of SOx through the meteorological mechanisms is not very efficient or that the generation of sulphur dioxide in the city balances the dispersion.

The NOx values for the three select sampling sites, namely, CZ, RZ, and IZ during the winter season was between 45.90-55.22μg/m^3, 10.39-25.71 μg/m^3, and 41.68-59.39μg/m^3, respectively in the year 2009-2010. The corresponding values in the year 2010-11was 43.78-64.8μg/m^3, 21.02-37.16μg/m3, and 34.15-59.39μg/m^3.

In summer of sampling period 2009-2010, the values in the CZ, RZ, and IZ ranged between 53.45-56.38μg/m^3, 9.57-16.21 μg/m^3, and 41.00-46.36μg/m^3, respectively.

The corresponding values in the year 2010-11 was 43.78-46.81 μg/m^3, 22.68-34.08μg/m^3, and 29.32-37.16 μg/m3. The values of NOx show a remarkable decline in the monsoon period. In the sampling year 2009-2010, the values obtained in the CZ, RZ, and IZ was between 49.60-55.76 μg/m^3, 18.74-24.12μg/m^3, and 33.82-48.87 μg/m^3, respectively. In 2010-2011, the corresponding value was found to be between 22.85-38.2μg/m^3, 16.4-26.48μg/m^3, and 33.82-43.63μg/m3. The value of NOx in the CZ, RZ, and IZ during post-monsoon period was found to be between 55.58-55.87 μg/m^3, 22.69-25.40 μg/m3, 51.37-57.64 μg/m^3, respectively. In 2010-2011, the corresponding value was found to be between 55.58-55.87 μg/m^3, 21.07-22.68 μg/m^3, and 41.03-46.81μg/m^3. The trend of NOx values is similar to that of NOx.

Table 1: SOx & NOx profile at different locations of Ranchi City, 2009-10

Month	Commercial		Residential		Industrial	
	SOx	NOx	SOx	NOx	SOx	NOx
December	27.62	45.90	11.09	19.20	33.85	59.39
Januray	25.70	55.00	16.09	25.71	20.92	47.37
February	26.25	52.91	9.57	16.40	24.06	41.68
March	27.12	55.22	6.64	10.39	23.01	42.74
April	27.53	54.33	10.60	9.57	20.41	41.00
May	28.84	53.45	11.71	15.68	24.12	46.36
June	27.77	56.38	11.81	16.21	27.17	48.87
July	26.31	49.60	12.03	24.12	26.31	47.61
August	26.31	52.64	11.87	20.16	22.97	33.82
September	28.35	55.76	12.33	18.74	27.78	48.28
October	28.04	55.58	15.30	25.40	30.44	57.64
November	27.84	55.87	13.92	22.69	30.85	51.37

Table 2: SOx & NOx profile at different locations of Ranchi City, 2010 -11

Month	Commercial		Residential		Industrial	
	SOx	NOx	SOx	NOx	SOx	NOx
December	30.69	64.8	15.16	21.02	33.87	59.39
Januray	27.57	51.03	11.87	26.93	29.07	42.69
February	27.78	55.05	14.36	37.16	21.03	34.15
March	25.24	73.78	20.18	23.02	17.14	47.12
April	26.76	46.81	16.09	25.71	25.67	34.34
May	25.67	43.91	25.26	34.08	28.22	37.16
June	28.25	43.78	7.27	22.68	28.25	29.32
July	21.48	22.85	12.75	24.52	16.84	39.13
August	14.34	36.13	10.39	16.4	12.97	33.82
September	16.87	38.2	21.2	26.48	25.04	43.63
October	28.04	55.58	12.83	21.07	27.57	41.02
November	27.84	55.87	14.36	22.68	29.90	49.81

CONCLUSION

The data on NOx/SOx ratio shows that the atmospheric pollutants originated mostly from traffic emissions. The lower NOx/SOx ratio typically characterizes the point sources using high content sulphur coals SOx and NOx are water soluble which dissolved in the rain water and washes away. Hence in the rainy season the concentration of these pollutants is at the minimum level.

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