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Levels of Nitrogen Dioxide of Atmospheric Air, in Maiduguri, Borno State, Nigeria

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Abstract: Atmospheric air was collected using Absorption train method from Shukwari Ward of Maiduguri Metropolis, Nigeria between the periods of January to December, 2004 and was analyzed for nitrogen dioxide by colorimetric method. The Nitrogen dioxide ranged from 0.321-0.078082 μg m^{-3}. for day times hours (8:00am-5:0pm), while for night times it could also be observed that concentrations between the soft hours of 1:00-3:00 am were relatively stable for the period of analysis with the exception of December, May and June, 2004. The mean day time's concentrations with error bars of NO_2 ranged from 0.253 ± 0.101-0.159 ± 0.082 μg m^{-3}. The highest mean concentration was determined in March while the lowest was observed in December, 2004. The highest night time concentration peaked in June while the lowest was determined in November. Statistical data handling by regression analysis ($p<0.05$) of day and night concentrations of NO_2 showed no correlation ($r = 0.4$). From the results, the concentration of NO_2 was within the World Health Organization and other national guideline values for clean air.

Key words: Absorption train, atmospheric air, nitrogen dioxide, maiduguri, Nigeria

INTRODUCTION

Atmospheric pollution, which had received little attention into the past, has become a subject of national interest in the last few years. There are numerous human activities, which result in the environmental release of potential toxic substances in the atmosphere (Aas *et al*., 1999; Campbell *et al*., 1994). The identity of these sources has been established in most cases but their quantitative importance is only rarely determined (Fähnrich *et al*., 1993). The air dust may have variety of sources (Caporn, 1992). The chemical composition of all the emission sources varies strongly. In order to trace down the pollution sources and to determine the extend of the anthropogenic contribution; a fundamental study of the chemical composition is necessary (Berkowicz *et al*., 1997).

The greatest air pollution in the Nigeria environment is atmospheric dust (Akeredolu, 1989). Several authors have determined the Nitrogen dioxide constituents of atmospheric air (Kelly *et al*., 1990; International Organization for Standardization, 1981; Bowen *et al*., 1994) Nitrogen dioxide (NO_2) has irritating effects on mucous membrane and higher doses of NO_2 cause bronchitis and respiratory problem (Bylin, 1993; International Organization for Standardization, 1981). An exposure towards 150-200 ppm of NO_2 results in *Bronchiolitis* "firbosa obliteteous" a dangerous disease which occurs within 3- 5 weeks after the exposure. Inhalation of 500 -600 ppm of NO_2 for 2-10 days results in death. Other effects of NO_2 include lowering of resistance to influenza and eye irritation (Pavlenko and Volberg, 1991). Nitrogen dioxide (NO_2) at 100 ppm level is generally most fatal because of pulmonary edema (Ferm and Svanerg, 1993). Both NO and NO_2 are fairly toxic at low concentrations (Bylin, 1993). Nitrogen dioxide (NO_2), being about 5 times as toxic as NO is responsible for destructive metabolism in the body (Kelly *et al*., 1990). Threshold Limit Values (TLV) of NO and NO_2 are 25 and 5 ppm respectively (Kelly *et al*., 1990).

The greatest air pollution in the Nigeria environment is atmospheric dust (Akeredolu, 1989). The major air pollutants found in Maiduguri Metropolis and elsewhere in general are carbon monoxide, carbon dioxide, oxides of nitrogen, oxides of sulphur, ash, hydrocarbons, photochemical oxidants and particulate matte (Ogugbuaja and Barsisa, 2001).

Maiduguri, (Lat. 11° 50'N, Long 13° 10'E) is located in Borno State, occupies North east position of Northern Nigeria. It is underline by the sediments of the Chad basin. The temperature ranges from 22-28°C, with means of the daily maximum exceeding 40°C before the onset of the rain during March, April and May. It has a minimum

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temperature drop as low as 12°C in December-February. Borno State is known for its high commercial activities with its few scattered industries located in the state capital (Maiduguri). The state share borders with Chad, Cameroon and Niger Republic and records a lot of transportation activities within and to the neighbouring countries by heavy trucks. Consequently, toxic waste from exhaust of cars, motorcycles and trucks are emitted into the atmosphere. Welding and construction of metal doors and windows is commonly seen by the major roads in Maiduguri. These welding activities release a lot of metal particles into the environment. Lack of steady power supply in Maiduguri and elsewhere in the state, compelled business activities to rely on generator sets as alternative power source which in turn emit some pollutants into the atmosphere.

The aim of this study is to look at the nitrogen dioxide in atmospheric air in Maiduguri, Borno state, Nigeria. Therefore, the information will provide a baseline data for future use.

MATERIALS AND METHODS

Sample and sampling: This study was conducted in Maiduguri; samples were collected from Shukwari Ward of Maiduguri metropolis. Atmospheric air was collected using Absorption train (Ogugbuaja and Barsisa, 2001). Flask A had 100 mL of the absorbing reagent (Sulphanilic acid and N-(1-naphthyl)-ethylene diamine dichlorohydrate); flask B contained CaO used as a moisture trap.

Samples were collected using the vacuum pump at an average of 2 h sampling period using a stop clock. The samples point was fixed while the cardinal directions of collections were alternated periodically to the wind direction. The high volume atmospheric air sampler operates at a normal flow rate of 0-4L min^{-1}. A total of 480 L air was collected at each occasion. The sampler (Fig. 1) was placed on the roof top of storey buildings with a protective slab base to avoid being blown away by wine, to prevent obstruction from nearby buildings and to minimize collection of dust from the underlying surface. The selected sampling site is in the heart of the city were there is residential and public building. A total of 36 air samples representative of ambient air were collected for day time (8-5 pm) and night time (7-3 am) for each month from January-December 2004.

Determination of nitrogen dioxide concentration in atmospheric air: Nitrogen dioxide was determined using colorimetric method the absorbance of the samples were determined at 550 nm using colorimeter. The absorbances

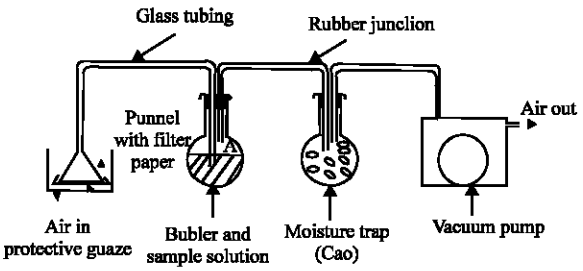

Fig. 1: Apparatus for the Measurement of NO_2

were then compared with a standard curve of NO_2. The various concentrations of NO_2 in the sample solution were extrapolated from the standard curve after subtracting blank determination.

The concentration of NO_2 in air is calculated using the equation (Radojevic and Bashkin, 1999).

$$NO_2\ (\mu gm^{-3}) = 0.82 \times C \times V_S/V_A$$

Where C is the concentration of NO_2 in the absorbing solution (μgmL^{-1}), V_S is the volume of absorbing solution (mL), V_A is the volume of air sampled in m^3 and 0.82 is the sampling efficiency.

RESULTS AND DISCUSSION

Figure 2, shows the 2-hourly day time (8:00 am-5:00 pm) variations of NO_2 concentrations determined in Maiduguri (January-December 2004). The concentrations ranged from 0.321-0.078 $\mu g\ m^{-3}$ for the day time hours (8:00 am-5:00 pm). The highest concentration peaked between the soft hours of 11:00 am-1:00 pm in July while the lowest were determined between the soft hours of 8:00-10:00 am in August, September and December, 2004. Generally, the day time concentrations of NO_2 peaked between the soft hours of 11:00 am-1:00 pm.

Figure 3, shows the mean day time concentrations with error bars of NO_2 determined in Maiduguri. The concentrations ranged from 0.253±0.101-0.159±0.082 $\mu g\ m^{-3}$. It could be observed that the highest mean concentration was determined in March while the lowest was observed in December, 2004.

Figure 4, shows the 2-hourly variations of NO_2 concentrations at night time (7:00 pm-3:00 am). It could be observed that NO_2 concentrations peaked between the soft hours of 10:00 pm-12:00 am. It could also be observed (Fig. 4), that concentrations between the soft hours of 1:00-3:00 am were relatively stable for the period of analysis with the exception of December, May and June, 2004. These sharp increases in concentrations were as a

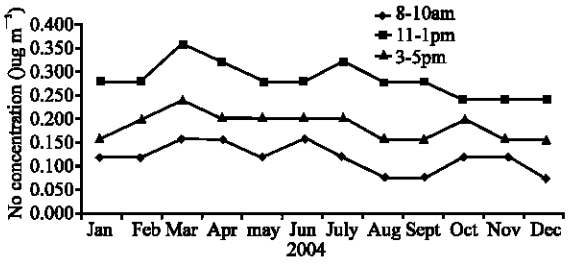

Fig. 2: Variations of NO_2 Concentrations at Day Time (8am-5pm) of Air Samples of Maiduguri

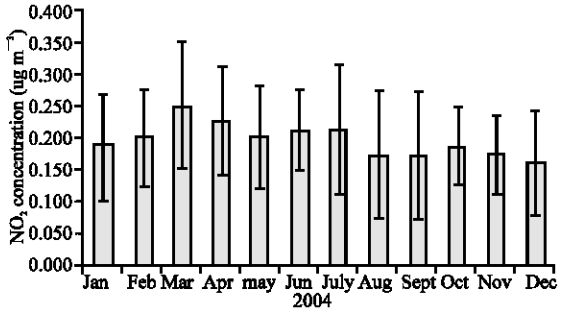

Fig. 3: Plot of Mean NO_2 Concentrations at Day Time in Air Samples of Maiduguri

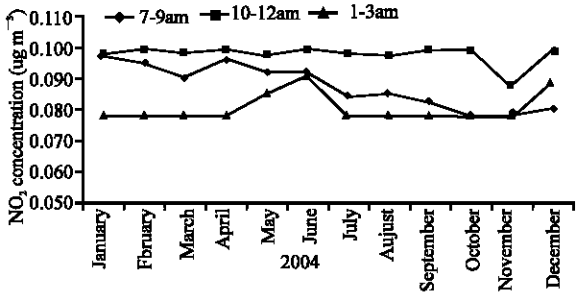

Fig. 4: Variations of NO_2 Concentrations at Night Time (7pm-3am) of Air Samples of Maiduguri

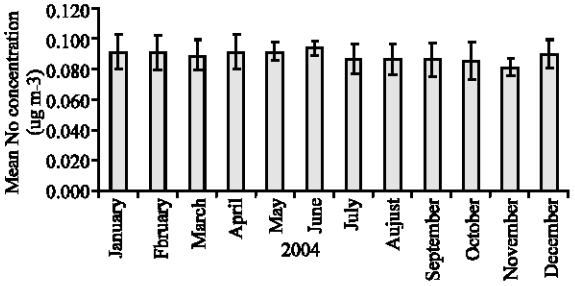

Fig. 5: Plot of mean NO_2 concentrations at night time in air samples of maiduguri

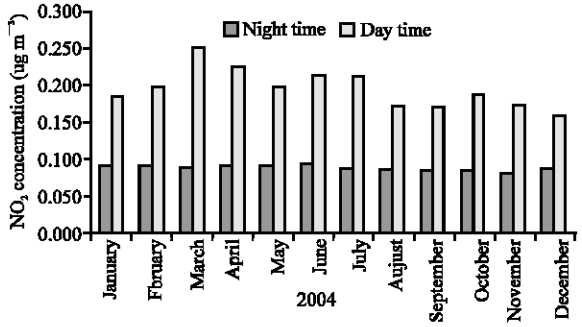

Fig. 6: Monthly variation of NO_2 concentrations of air samples of maiduguri

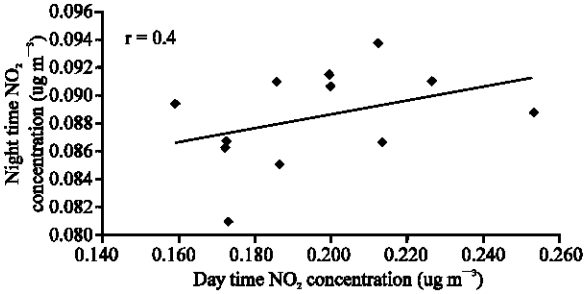

Fig. 7: Scatterplot of NO_2 at day and night times of air samples of maiduguri

result of turbulence and inversion. Tukur (1998) and Kato *et al.* (1999) noted that turbulence of air will cause atmospheric pollutant to recirculate around and thereby increase the concentration of pollutant. Das (1997) noted that studies carried out in Raipur (India) showed that NO_2 concentrations were higher during peak traffic hours. Comparison between week days and Sundays showed that levels of NO_2 were least during Sundays-hence having least traffic (activities). Similarly, inversions tend to increase the levels of pollutants as a result of precipitation. However, as activities diminishes which also accompanied reduction of emissions (pollutants) towards the morning hours (1:00-3:00 am, levels of NO_2 were also found to decreased.

Figure 5 also shows the mean NO_2 concentrations with the error bars at night time in Maiduguri. The highest night time concentration peaked in June while the lowest was determined in November, 2004.

Relating the day, night and monthly variations of NO_2 (Fig. 6), it was observed that day time concentrations were generally higher compared to the night time concentrations. This is not unexpected because when NO is released into the atmosphere from the various emission sources, it rapidly oxidised to NO_2 through processes involving ozone (O_3), peroxy-radicals (RO_2*) and hydroperoxy radical (HO_2*). Oxidation by radicals is faster and may cause high concentrations of NO_2 compared to decomposition of NO_2 to NO photochemically and

photolysis only occurs during day-hence the reason why day time concentrations of NO_2 were higher (Allegrini and Febo, 1995). This also confirms why the day time variations peaked between the soft hours of 11:00 am-1:00 pm (solar radiation peak period-Fig. 6).

Analysis of Variance (ANOVA) of data at $p<0.05$ for the soft hours of day time showed that there was a marked significant variation or difference in concentration of NO_2 determined. Further statistical analysis (Scheffè test) at $p<0.05$ showed that the marked difference was observed between 11am-1pm and 8-10am soft hours of the day time. Similarly, Scheffè test also proved that the marked differences in the night time were mostly observed between 10pm-12am, 1-3am and 7-9pm. By independent t-test at $p<0.05$, the overall variations in NO_2 between day and night showed marked significant difference at day time. Statistical data handling by regression analysis ($p<0.05$) of day and night concentrations of NO_2 showed no correlation ($r = 0.4$) as shown in Fig. 7.

CONCLUSION

Level of NO_2 for day and night time was within the WHO and FEPA standard for clean air, SO_2 showed no correlation for both day and night. Hence, based on the results obtained it can be concluded that the air was found not polluted as at the time of this study.

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