INDOOR/OUTDOOR AIR QUALITY NITROGEN-DIOXIDE RELATIONSHIP AT SELECTED LOCATIONS IN AGBOR; NIGER-DELTA REGION.

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Abstract

Much of the health impact from air pollution worldwide seems to occur among the poorest and most vulnerable populations. The main aim of this study was to determine the levels of nitrogen dioxide concentrations both outside and inside homes and estimate the indoor/outdoor ratios at selected areas in Agbor. Measurement was carried out at ten locations indoor and outdoor by use of Palmes diffusion tubes. Indoor and Outdoor NO_2 levels were determined every two weeks for the period October, 2008- September, 2009. The maximum mean monthly indoor and outdoor NO_2 values of 50.02µg/m^3 and 47.32µg/m^3 respectively were recorded at site AG/TL .The annual mean outdoor NO_2 concentration ranged from 8.75 – 37.86µg/m^3 while the annual mean indoor NO_2 levels ranged from 7.28 – 39.93µg/m^3.The mean indoor/outdoor ratio was 0.91 (s = 0.11). Statistical analysis show that there exist a positive correlation between indoor and outdoor NO_2 ($r = 0.87$; $p \leq 0.05$). When compared with statutory limits nationally (FMENV) and internationally (WHO), the values of NO_2 obtained in this study both indoor and outdoor lies below the permissible limits.

Keywords: Nitrogen dioxide, Correlation, indoor, outdoor, Agbor, Palmes diffusion tube.

Introduction

As a result of a variety of human activities, a large number of different toxic pollutants are emitted into the atmosphere. Exhaust emissions from automobiles contribute directly to adversely high ambient air pollutant concentration which is emitted in close proximity of the breathing zone of people. Although Nitrogen-dioxide (NO_2) occurs naturally in the environment, the largest contribution to ambient concentration comes from the burning/use of fossil fuel [1,2].The principal removal mechanism of NO_2 from the air is its oxidation by OH to form nitric acid (HNO_3), which then collects on aerosols or dissolves in precipitation and is subsequently scavenged by rainfall. Other pathways for direct NO_2 removal occur through canopy scavenging of NO_2 and direct, dry deposition of NO_2, HNO_3 and particulate nitrates to the land surface and the ocean.

Wide ranges of air pollutants are generated outdoors and are either known or suspected of causing adverse effects to human health and the environment [3]. Principally, pollutants found in urban areas are from short range sources including pollution from vehicle exhausts, combustion, standby generators, construction, demolition and nuisance sources such as cooking smells from kitchen extracts.

People spend most of their time indoors yet the majority of pollutant concentration data are based on measurement conducted outdoors. Outdoor pollutant concentration may not be reliable indicators of indoor and personal pollutant sources [4]. Although the toxicology of NO_2 exposure suggest the potential for respiratory symptoms and loss of lung function [5, 6] evidence from three decades of epidemiological studies linking NO_2 exposure to adverse health effects has been inconsistent. Some inconsistency may be explained by differences in measures of exposures [acute [7, 8] vs Chronic [7, 8, 9, 10]]. Long term exposure to high concentration of NO_2 is associated with 20% increase in the risk of respiratory illnesses in children [5, 11]. The main aim of this study was to determine the levels of nitrogen dioxide concentrations both outside and inside homes and estimate the indoor/outdoor ratios at selected areas in Agbor.

Methodology

Sampling Location

This study was conducted in Agbor(headquarters of Ika South Local Government Area, Delta-State) ,an emerging commercial transitory town for commuters travelling to the North, East and western parts of Nigeria.

Sampling Sites

Ten sampling points outdoor evenly and well spread with different traffic densities, human and commercial activities were selected on the basis of security of equipment, accessibility and available receptors to obtain maximum spatial variation on

NO_2 levels. The outdoor sampling points and their codes are presented in Fig 1 below. For the Indoor NO_2 monitoring, ten homes (one from each site) located approximately 6m away from the outdoor sampling points were selected for the indoor monitoring purpose. Indoor sampling was done at the centre of the living room. However, the selection of homes used in this study was purely voluntary.

NO_2 Monitoring

NO_2 measurement was carried out by using Palmes diffusion tubes. A Palmes diffusion tube/sampler is a device capable of taking up a sample of a gas or vapor from the atmosphere through diffusion or permeation into the interior of the tube where it is subsequently trapped by means of adsorption on the adsorbent. The sampler is basically an acrylic tube of 8.20cm long with cross-sectional area of $0.82cm^2$ machined at each end to accommodate closely fitting polyethylene cap. The sensitivity of this particular tube length and the sensitivity and selectivity of triethanolamine for NO_2 have been reported [1, 12, 13]. At the sampling locations, the tubes were exposed at a height of about 1.5 – 2.0m above the ground level. Nitrogen dioxide monitoring was done every two weeks for a period of twelve months (October 2008 – September 2009). A UV/visible spectrophotometer (Spectronic, 21 D) was used to determine the absorbance of both blanks and air samples at 540nm. The atmospheric concentration of NO_2 during the measuring period was calculated as described by Palmes et.al [14].

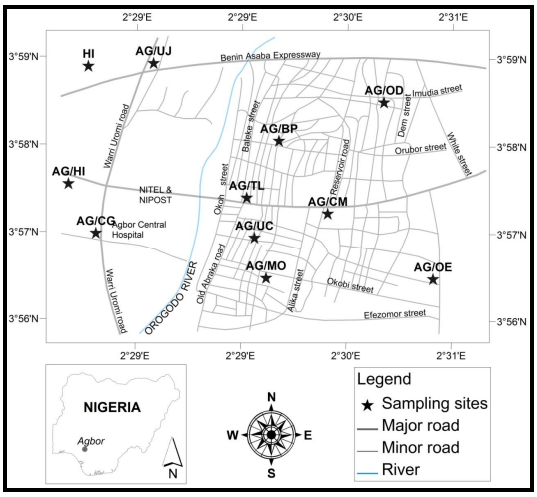

Fig 1 Base map of Agbor (Boji-Boji) town situated in Delta state, Nigeria showing street pattern and sampling sites

Results and Discussion

The result of the outdoor and indoor NO_2 levels for the period is shown in Table 1 below. From the results, the maximum monthly indoor (ID) and outdoor (OD) values of $50.02\mu g/m^3$ and $47.32\mu g/m^3$ respectively was obtained in the dry season months of December'08 and January'09 at site AG/TL. The high indoor and outdoor NO_2 values recorded for this site correlates with the high traffic density and the use of generators for commercial activities observed in this area. Other locations with high ID/OD values are; AG/UC $44.18\mu g/m^3$ (ID), $42.18\mu g/m^3$ (OD) and AG/CM $40.87\mu g/m^3$ (OD). Generally the ID and OD values recorded for sites AG/OD and AG/OE were low ($6.11\mu g/m^3$, $6.92\mu g/m^3$ and $7.00\mu g/m^3$). This may be due to the fact that these sites are purely residential and located at the outskirt of the city with very low traffic.

The annual mean ID/OD NO_2 concentration for the different locations does not follow any clearly defined pattern (Table 2), in some locations the ID values were higher than the OD values (AG/TL). This could be due to the fact that some of the homes studied had very poor ventilation system and also likely due to the fact that greater photochemical reactions of NO_2 can occur in the atmosphere. Generally, the mean indoor/outdoor ratio was 0.91 (s = 0.11). This high indoor/outdoor ratio is a sign of a high level of penetration of outdoor air indoor.

Regression Equation=4.097+0.898x
SpearmanRank Correlation=0.867

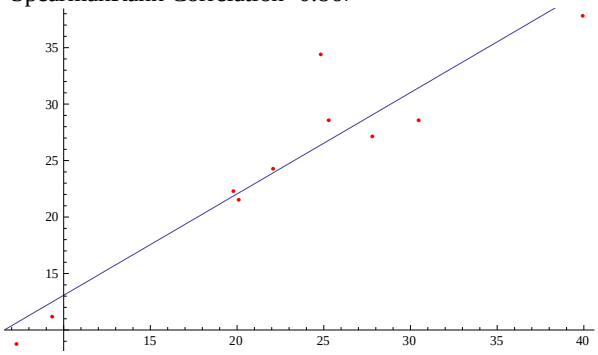

Fig 2. Graph of indoor vs outdoor NO_2 Concentration

Fig 2 shows the correlation between ID and OD NO_2.There was high correlation between ID and OD air ($r = 0.87$, $p < 0.05$); this could be due to factors such as generation rate of pollutant indoors, outdoor pollutant concentration, air exchange rate and pollutant penetration efficiency from outdoor to indoor environment [15, 16].

Table 1. Mean monthly Indoor/Outdoor NO_2 concentrations ($\mu g/m^3$)

		Locations									
Period		AG/UJ	AG/HI	AG/CG	AG/TL	AG/UC	AG/BP	AG/OE	AG/CM	AG/MO	AG/OD
Oct	ID	27.00	25.10	16.31	32.41	26.26	19.10	5.62	23.11	23.63	11.42
’08	OD	24.00	23.11	18.21	29.70	24.70	19.86	7.00	34.10	27.11	15.22
Nov	ID	30.10	26.80	22.44	40.65	32.47	23.42	5.94	25.31	21.77	12.69
’08	OD	29.49	31.06	24.04	38.93	30.20	26.59	9.04	39.35	25.21	17.44
Dec	ID	30.42	27.02	25.00	50.02	44.18	22.76	8.03	28.93	23.04	12.16
’08	OD	33.40	35.31	25.36	46.80	42.54	26.27	10.00	40.87	26.82	11.70
Jan	ID	30.18	27.10	21.37	49.34	34.71	24.00	8.68	28.76	22.97	13.00
’09	OD	33.17	35.06	24.36	47.32	33.11	25.87	10.03	38.39	25.77	15.69
Feb	ID	29.25	26.88	23.79	46.77	33.01	24.03	7.99	26.91	22.57	13.32
’09	OD	30.88	32.44	24.02	45.63	32.04	25.81	9.61	37.88	25.01	15.49
Mar	ID	29.88	26.75	24.00	48.00	32.68	25.04	7.85	26.88	22.01	13.44
’09	OD	31.66	32.95	24.77	45.60	31.33	26.00	9.20	37.10	24.63	15.21
Apr	ID	27.41	27.18	17.61	30.00	21.72	24.79	7.44	25.25	15.11	6.04
’09	OD	18.66	20.14	18.10	27.60	18.79	26.50	9.02	30.23	14.77	7.02
May	ID	28.76	25.33	18.06	32.74	23.91	23.68	6.92	24.17	16.14	6.73
’09	OD	22.01	22.66	19.42	30.20	22.60	25.20	8.11	31.47	18.62	7.11
Jun	ID	25.32	22.60	18.73	35.00	32.64	15.66	7.00	22.11	17.20	6.00
’09	OD	27.44	27.40	20.00	34.10	30.15	18.70	8.94	30.00	19.77	8.04
Jul	ID	24.91	22.13	18.19	35.96	30.18	20.04	7.68	23.06	17.14	5.18
’09	OD	25.23	28.10	20.46	34.77	28.26	24.20	8.11	32.11	21.00	6.11
Aug	ID	25.00	24.00	17.24	40.00	27.34	20.68	8.00	22.00	18.73	6.21
’09	OD	24.01	28.00	19.77	37.20	24.10	23.79	7.97	30.02	20.18	6.92
Sept	ID	25.72	22.11	18.39	38.23	26.95	21.25	6.23	21.65	17.00	6.03
’09	OD	26.20	27.01	20.20	36.41	24.66	23.00	8.00	30.77	19.02	8.00

Table 2 Indoor/Outdoor NO_2 Ratio

s/n	Code	Annual mean NO_2 ($\mu g/m^3$)		
		Indoor	Outdoor	Ratio
1	AG/UJ	27.83±2.187	27.18±4.651	1.02
2	AG/HI	25.25±2.040	28.60±4.936	0.88
3	AG/CG	20.09±3.034	21.56±2.718	0.93
4	AG/TL	39.93±7.088	37.86±7.056	1.05
5	AG/UC	30.50±5.920	28.54±6.195	1.07
6	AG/BP	22.08±2.785	24.32±2.619	0.91
7	AG/OE	7.28±0.950	8.75±0.924	0.83
8	AG/CM	24.85±2.580	34.36±4.098	0.72
9	AG/MO	19.78±3.160	22.33±3.936	0.88
10	AG/OD	9.35±3.522	11.16±4.355	0.84

Intercomparison of the annual mean ID and OD values with regulatory limits show that the values obtained in this study are well below the World Health Organization [17] annual limit of 40$\mu g/m^3$ and the Federal Ministry of Environment [18] daily limit of 75-113$\mu g/m^3$. Mandel et al., [19] studied indoor NO_2 concentrations in some residences of Calcutta and also found annual mean NO_2 concentration well below the values prescribed by EC for European countries (45ppb)**.**

Conclusion

In this study, ID/OD NO_2 relationship was investigated in ten locations. Indoor NO_2 values correlate positively with the Outdoor values. All sampling sites from where air samples were investigated gave NO_2 levels below the limits set nationally (FMENV) and internationally (WHO). The potentials of the data generated in this study can form the basis for environmental awareness and implementation of appropriate ambient air quality.

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