Chemistry Research Journal, 2020, 5(4):81-87

Available online www.chemrj.org

Research Article

ISSN: 2455-8990
CODEN(USA): CRJHA5

Spectrophotometric determination of ambient air Sulphur(IV) oxide concentration in the commercial city of Aba, Nigeria

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Abstract In this research work, West-Gaeke method was used to determine the ambient air SO_2 concentration in the commercial city of Aba. Sampling and analysis started fromMarch and stopped in December 2013 which covered the wet and dry seasons of that year. The mean concentration during the dry season was 0.174 ppm while that of wet seasons 0.143 ppm. The concentration during the wet season was 9.78 % lower than the dry season due to rain attenuation. The highest concentration obtained was 0.255 ppm at Plot 1 Port Harcourt Road (Latitude $05^0$06'03, Longitude $007^0$21'44) during the dry season while the lowest concentration was 0.032 ppm at Plot 100 Ngwa Road (Latitude $05^0$06'01, Longitude $007^0$22'15) during the wet season. The overall average concentration over the city was 0.156 ppm. The value is higher than the range of standard limit of the Federal Environmental Protection Agency (FEPA), Nigeria of 0.001-0.01 ppm for air quality standard which shows that Aba is polluted by SO_2.

Keywords Sulphur(IV) oxide; Air pollution; Ambient air; Concentration; Locations

1. Introduction

Environmental pollution which can cause deterioration of living conditions is a serious problem because breathing of safe air is important to human life. However, the human population in developed and developing countries are compelled to breathe polluted air from biomass combustion and other diffused sources [1]. The air we breathe is a mixture of gases, small solid and liquid particles.

Air pollution is the introduction of particles, biological molecules and other harmful materials into the earth's atmosphere, causing diseases, allergies, and death to humans, damage to other living organisms such as animals and food crops or the natural or built environment. According to the 2014 WHO report, air pollution in 2012 caused the death of around 7 million people.

Sources of air pollution is diverse and it is impossible to discriminate between domestic and traffic sources. Some substances come from natural sources while others are caused by human activities such as use of motor vehicles, domestic activities, industries and business. Studies have shown that rising discomfort, increasing airway diseases and deterioration of artistic and cultural patrimony in urban centers are caused by particulate matter and gaseous emissions from industries [2]. There are some non combustion sources such as building construction and quarrying. Some of these gaseous air pollutants are Sulphur (IV) oxide (SO_2), Nitrogen Oxide (NO_x), Ozone (O_3), Carbon (ii) Oxide (CO) etc.

Although Sulphur(IV) oxide is not a "green-house gas", its presence in the atmosphere may influence climate [3]. Sulphur(IV) oxide can react with a variety of photo-chemically produced oxidants to form sulphate aerosols [4]. The concentration of these particulate are increasing due to the burning of Sulphur containing fossil fuels. Anthropogenic Sulphur(IV) oxide emissions world-wide is estimated to be 70-80 million tons per year while the natural emissions have been estimated to be 18-70 million tons per year [5]. Also more than 80% of anthropogenic Sulphur(IV) oxide arises from fuel combustion with three quarters of these from Coal. It has been observed that the highest source of Sulphur entering the atmosphere is hydrogen sulphide (H_2S) originating from the decay of organic matters and the biological reduction of sulphates especially by anaerobic bacteria [4, 6]. This H_2S is rapidly converted in the atmosphere into SO_2.

As many Cities around the world become congested and industrialized, there is increasing concern over the level of urban air pollution being generated and in particular its impact on human health and environmental damage. For instance, a statistically significant rise in deaths was found in New York City and Mexico with increased levels of SO_2 in 1978. During a five day period marked by temperature inversion; between 3500 and 4000 deaths in excess of normal occurred with 1.3 ppm SO_2 level recorded [6]. If the concentration of SO_2 continues to accumulate, the overall concentration can have a negative effect on health, vegetation and structure.

Monitoring the concentration of SO_2 in the atmosphere is therefore very important. Many methods including Phenanthroline Method, West-Gaeke method, Fluorescing method, Colorimetry method etc have been used in determining the amount of Sulphul (IV) oxide in the atmosphere [7].

In this work, West-Gaeke method was used to determine the amount of Sulphur(IV) oxide concentration in the atmosphere within the commercial city of Aba in Nigeria.

2. Materials and Methods

2.1. Monitoring Site (Mapping Area)

Aba is a commercial city in Nigeria located on latitude 5^o 09^o 07" N and longitude 7^o 20' 22' E and in the tropical rain forest region in Nigeria. Aba is located in Niger Delta Region in Nigeria. The town has been estimated to be a major economic contributor to the country Nigeria in areas such as textiles, pharmaceuticals, plastics, timbers, shoe manufacturing industries. Additionally, the city also has brewery, distillery and other famous handicraft. It has a projected human population of about four million (4,000,000) [8]. Figure 1 shows the map of Aba and the 10 sampled locations while Table 1 lists the 10 locations and their coordinates.

Table 1: 10 sampled locations with their coordinates

S/No	Locations	Coordinates		
		Latitude (^{0}N)	Longitude (^{0}E)	Altitude (M)
1	Aba Main Park	$05^0$06'43	$007^0$22'16	62
2	Plot 1 Port Harcourt Road	$05^0$06'03	$007^0$21'44	47
3	Plot 100B Ngwa Road	$05^0$06'01	$007^0$22'15	51
4	150 Umoba Road	$05^0$07'57	$077^0$23'13	71
5	Abia State Polytechnic	$05^0$07'45	$007^0$21'36	67
6	Plot 160 Faulks Road	$05^0$07'16	$007^0$21'12	70
7	Plot 108 Omuma Road	$05^0$07'03	$007^0$22'53	48
8	25 Crystal Park Road	$05^0$05'26	$007^0$21'00	51
9	Plot 77 Aja Road	$05^0$05'42	$007^0$22'44	52
10	Plot 50 Ikot Ekpene Road	$05^0$06'51	$007^0$23'08	61

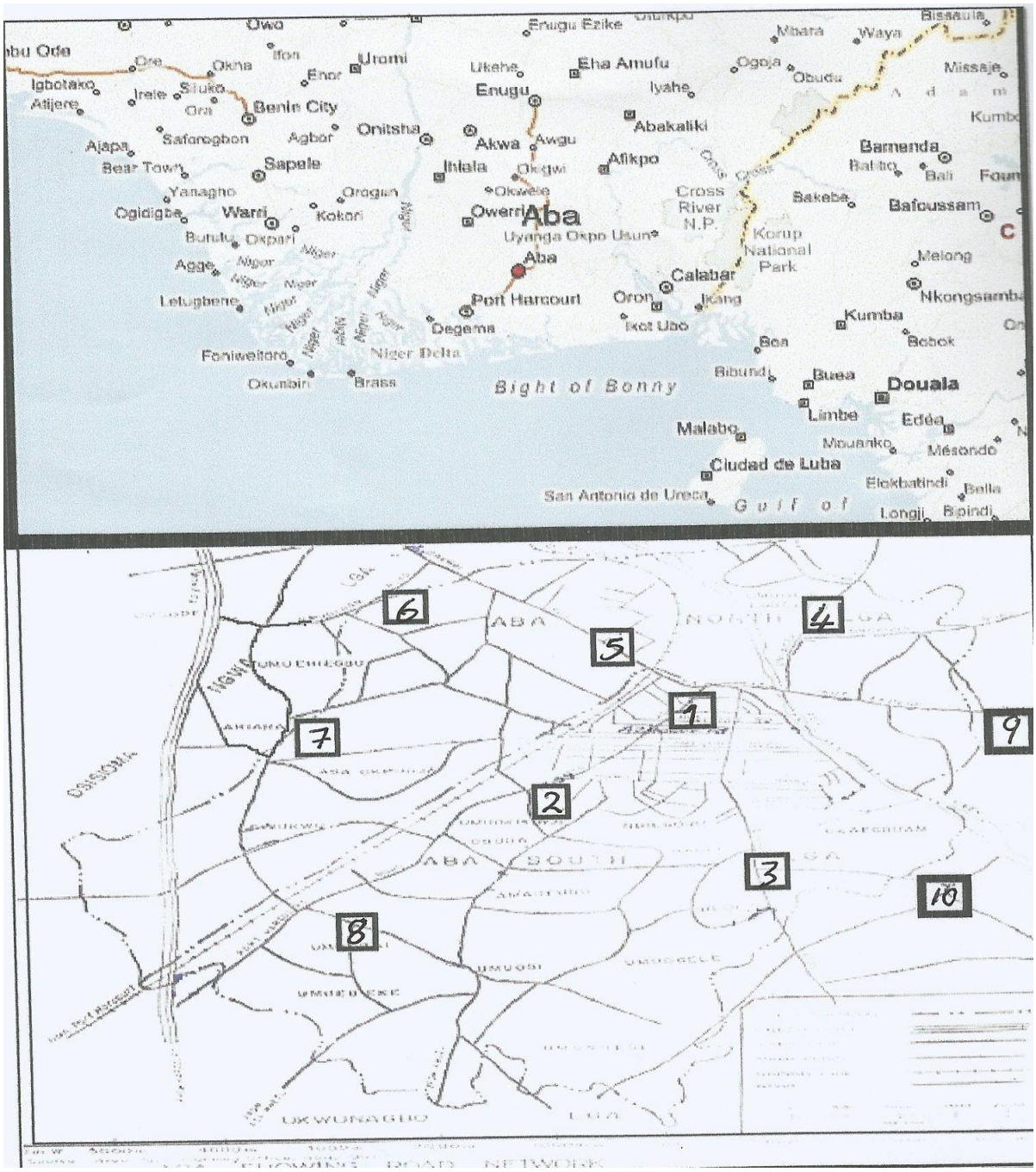

Figure 1: Map of Aba showing the 10 sampled locations

Method

The West-Gaeke method was used in this work (West-Gaeke, 1956). This method involves the use of potassium tetrachloromercurate (TCM) solution to absorb air from the atmosphere. The resultant dichlorosulphitomercurate complex formed was treated with pararosaniline and formaldehyde which results to formation of intensely coloured solution of pararosanilinemehtylsulphonic acid. At 560 nm, the absorbance of the coloured solution was measured using Spectrophotometer.

Results

The results obtained across the 10 locations sampled are presented in figures 2, 3, 4 and 5. The monthly variations of SO_2 concentration in wet and dry seasons sampling locations are shown in figures 2 and 3 respectively.

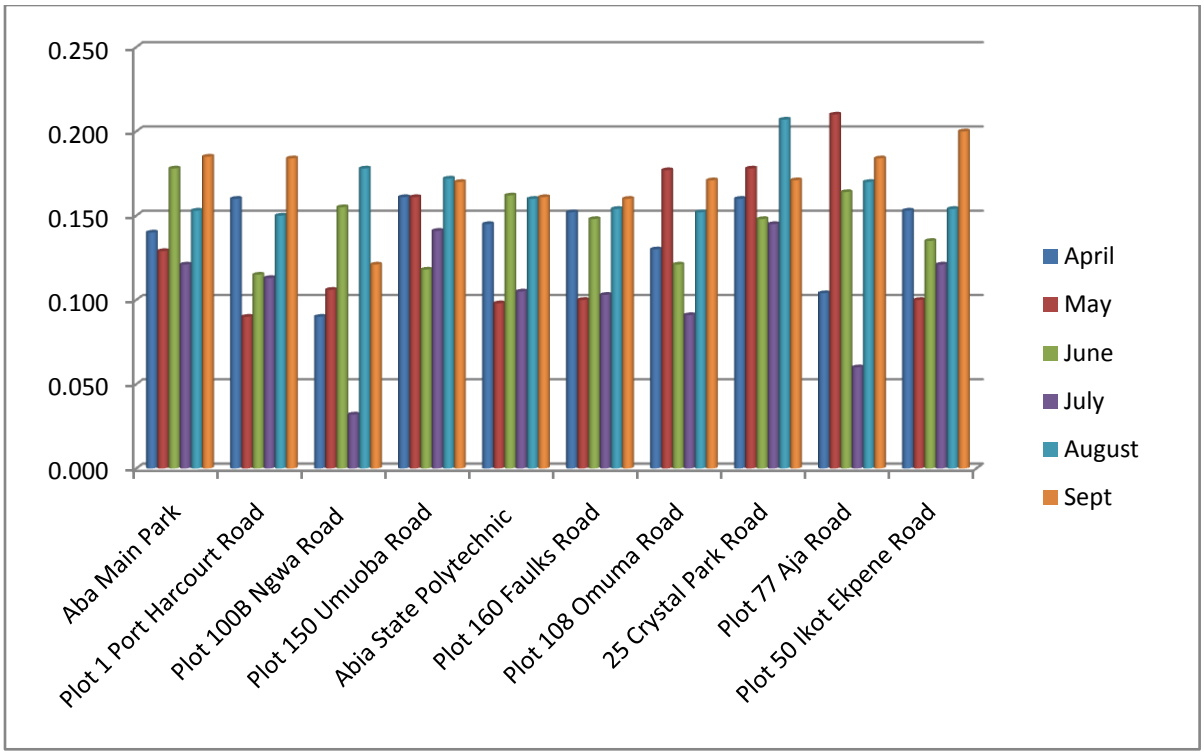

Figure 2: Monthly variation of SO_2 in the various sampling locations during the wet season

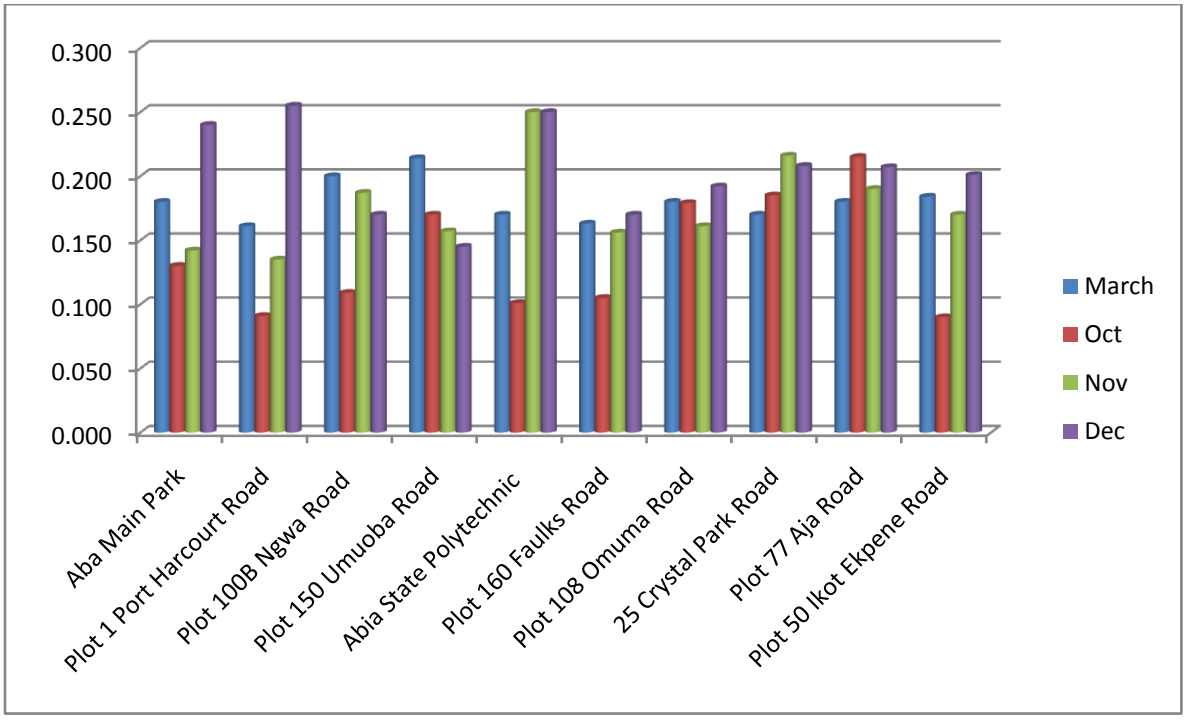

Figure 3: Monthly variation of SO_2 in the various sampling locations during the dry season

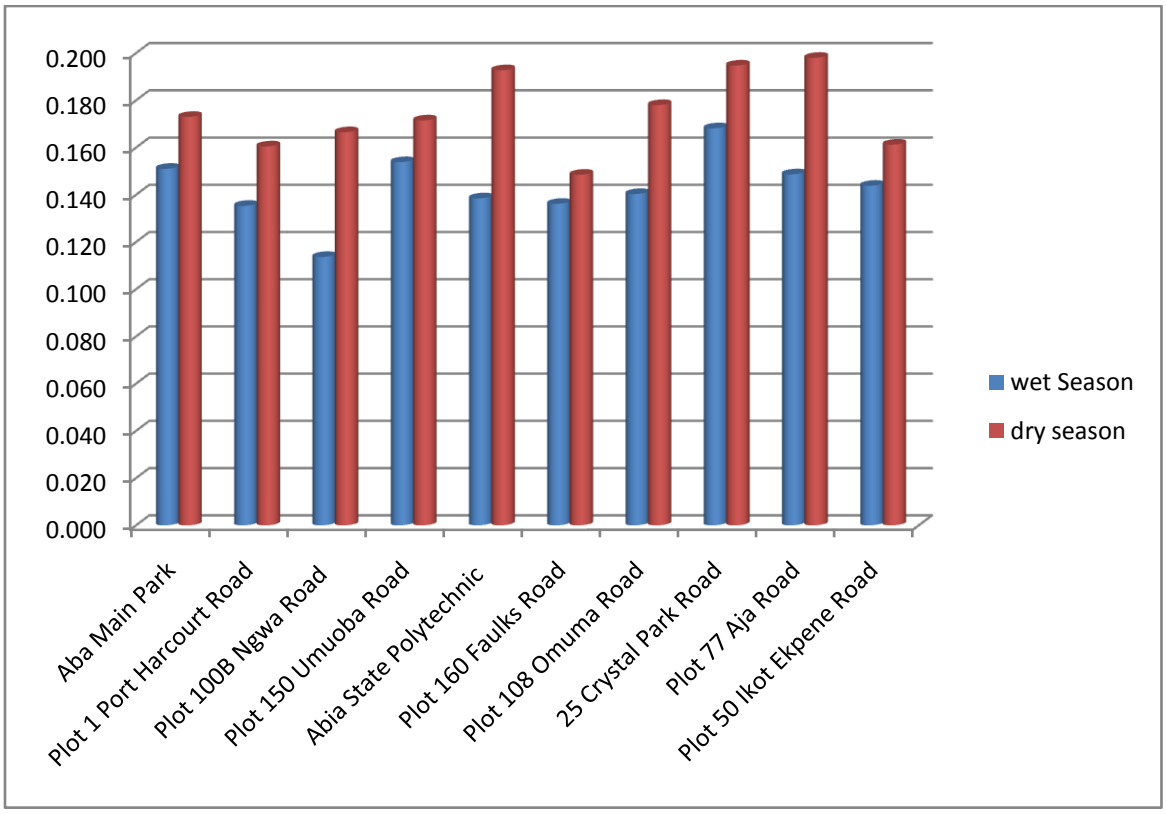

Figure 4: Seasonal variations of SO_2 at various locations

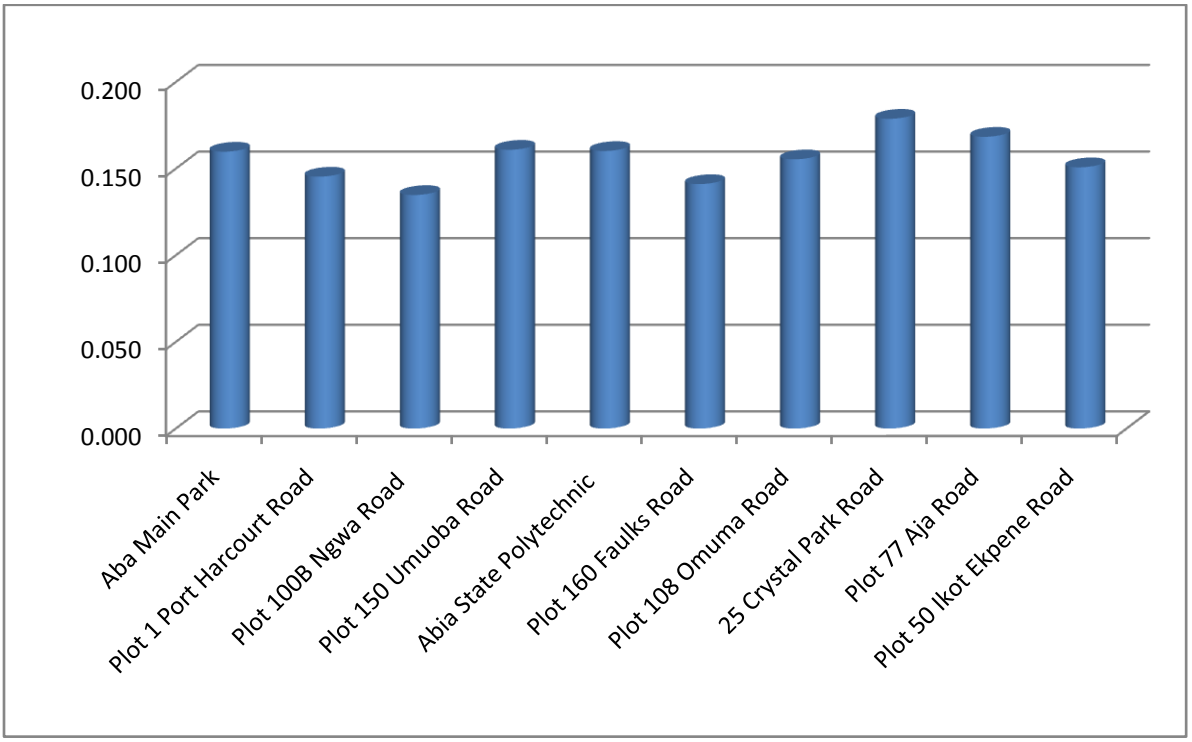

Figure 5: Variations of average concentration of SO_2 at different locations

Discussion

The average monthly variations of SO_2 concentrations across the 10 sampled locations in the commercial city of Aba are shown in figures 2 to 5.The results ranged from 0.032 ppm at Plot 100B Ngwa Road in July to 0.255 ppm at Plot 1 Port Harcourt Road in December, 2013. The range of other results obtained at different locations are as follows: Aba main park (0.129-0.240 ppm), Plot 1 Port Harcourt Road (0.090-0.255 ppm), Plot 100B Ngwa Road (0.032-0.200 ppm), Plot 150 Umuoba Road (0.118-0.214 ppm), Abia State Polytechnic (0.098-0.250 ppm), Plot 160 Faulks Road (0.100-0.192 ppm), 25 Crystal Park Road (0.145-0.216 ppm), 77 Aja Road (0.060-0.215 ppm) and Plot 50 Ikot Ekpene Road (0.90-0.201 ppm).

The results when compared showed that SO_2 concentration varies from one location to another. Figures 5 showed that Aba Main Park (0.160 ppm), Crystal Park Road (0.179 ppm) and 150 Umuoba Road (0.161 ppm) and 77 Aja Road (0.168 ppm) recorded highest level of SO_2 concentration among all the locations sampled. The areas are characterized by so many SO_2 generating activities such as dumpsite, burning of generating sets, heavy road traffic etc. Plot 1 Port Harcourt Road, 100B Ngwa Road and Plot 160 Faulks Road which are in residential area have relatively lower amount of SO_2 concentration than the high traffic areas, market and industrial areas.

Seasonal variations (dry and wet seasons) of SO_2 concentrations at different locations in the area are shown in figure 4. The results obtained during the dry season ranged from 0.032-0.255 ppm while wet season's results ranged from 0.032-0.200 ppm (Fig. 4). The results showed that there was increase in the pollutant concentration during the dry season. However, the other of SO_2 concentrations decreased as follows: 9>8>5>7>1>4>3>2=10>6 while order of decrease in the concentration during the wet season is 8>4>1>9>10>7>5>6>2>3. The major reason for the low concentration in wet season is precipitation. SO_2 is soluble in water which dissolves in rain water in rainy season. The rain in the atmosphere is converted into H_2SO_4.Conversely, no precipitation and burning of Sulphur containing materials will increase SO_2 concentration in the dry season. The observation agrees with the report of Abdul Raheem *et al.* [9] which observed that SO_2 concentration in Ilorin was higher in the dry season.

The results also revealed that all the locations sampled with the exception of 100 B Ngwa Road (in December) have the highest SO_2 concentration level (0.204 ppm). The month December is the peak of dry season in the tropical rain forest zone (with little or no rainfall) [10]. The mean of the monthly average of SO_2 concentration within Aba (0.156 ppm) exceeded the standard regulatory limits of FEPA, Nigeria (0.001-0.01 ppm). The result when compared to the SO_2 concentration in Kano State which ranged from 3.21-5.18 ppm (30 minutes exposure) as reported by Okunola *et al.,* [11] showed that the level of SO_2 in Aba was lower than that of Kano metropolis. The study also shows that there is need for regular monitoring and control of the ambient air in the commercial city of Aba by the relevant agencies. The statistical analysis of the results was done using SPSS. There was a significant difference (P= 0.05) between the results of the dry and wet seasons.

4. Conclusions

- The result of research revealed that the SO_2 concentration in all the locations sampled were above the standard limit stipulated by Nigerian Federal Environmental Protection Agency (FEPA). Therefore, Aba metropolis is polluted by SO_2.
- The level of SO_2 concentration in wet season was lower than that of dry season which shows that SO_2 pollution is usually higher in dry season due to rain attenuation during the wet season. The sources of the gas in the city was observed to be from burning of generator sets, gaseous waste from chemical industries, exhaust gas from vehicular traffic, gas evolution from solid waste dumpsites etc.
- It is therefore recommended that Government and Private Environmental Agencies should do more to keep the level of SO_2 in Aba metropolis within the safe limit.

Acknowledgement

I wish to express my gratitude to the following persons who in one way or the other helped me in the course of this research work: Mrs Ngozi T. Elui, Bertha O. Nkwocha and IlemIyam Owali.

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