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Concentrations and Daily Variations of Sulphur Compounds in the Waste Dumpsite at Osisioma Ngwa Local Government Area, Abia State

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ABSTRACT

A study on the concentrations and daily variations of SO_2 and H_2S in the waste dumpsite at Osisioma Ngwa Local Government Area, Abia State, was carried out using some hard hold air quality monitors. Results of SO_2 and H_2S obtained for morning and evening hours reading during the dry season to be for Umuigwe dumpsite SO_2(0.04:0.07), H_2S (0.70:0.30); Umujima dumpsite SO_2(1.37: 1.52), H_2S (0.80:0.30); Niger Stone dumpsite SO_2(1.62:0.04), H_2S (3.40:0.30); Uratta Amaisa dumpsite SO_2(0.09:0.04), H_2S (0.60:0.30); Eyimba market dumpsite SO_2(0.13:1.34), H_2S (0.10:0.91); Asaeme dumpsite SO_2(0.06:0.08), H_2S (0.34:0.90); and Owerrinta control location SO_2(0.02:0.01), H_2S (0.03:0.03). When comparing results with permissible maximum standard values obtained indicated air quality to be within good to moderate ambient air quality descriptions. However, the concentrations were higher with WHO recommended standard for SO_2 and H_2S emission. This indicates that the study area can be described to have poor air quality and which can be dangerous to human health.

Keywords: Air pollution monitoring, sulphur compounds, thermal power plants, waste, toxicity, habitat, Nigeria.

INTRODUCTION

The worldwide production and use of chemical compounds have increased tremendously since the Second World War. Much of this growth can be attributed partly to the needs of a growing population and partly to the development of new compounds for the sake of progress (Narayanan, 2009). The environmental impact of these chemical interventions has only slowly become apparent and is a cause for much concern. These chemical compounds when released into the environment through their deposit at dumpsite resist decay and are biologically non- degradable. Since air pollution may be define as any atmospheric condition in which certain substances are present in such concentration that they can produce undesirable effects on man and his environment, these substances are naturally present in the atmosphere in low concentrations and are usually considered to be harmless (ATSDR, 2001). However, due to high population escalation of human population growth, industrialization and thermal power plant, these have resulted to the release of these substances exceeding the levels of their pollutional load carried by the air (ATSDR, 2006). The focus of this study is with special reference to sulphur compounds released into the atmosphere from waste dump site at Osisioma Ngwa (Nwakanma *et al*., 2016). These include SO_2 and H_2S mostly released by fossil fuel (coal), based power generating plants (thermal plants) and industrial units such as emissions from petroleum refineries. From amongst several other major sulphur compounds in the atmosphere the oxides of sulphur are the most serious pollutants. The other S-compounds are carbonyl sulphide (COS), carbon disulphide (CS_2), dimethyl sulphide {$(CH_3)_2S$} and sulphates. The chief sources of oxides of sulphur are the combustion of coal and petroleum. Thus, most oxides come from thermal power plants and other coal – based plants (emissions released by burning of fossil fuel), smelting industries (smelting sulphuric containing metal ores) and other processes manufacture of sulphuric acid and fertilisers (Nkwocha and Pat-Mbano, 2010). Automobiles also released SO_2 in air which further compounds the deterioration of air quality. Burning of fossil fuels for power generation contributes to almost 60 -70% of total SO_2 emitted globally. SO_2 is a colourless gas with a characteristic, sharp, pungent odour. It is moderately soluble in water forming weakly acid sulphurous acid (H_2SO_3). It is oxidised slowly in clean air to sulphur trioxide. In a polluted atmosphere, SO_2 reacts photochemically or catalytically with other pollutants or normal atmospheric constituents to form sulphur trioxide, sulphuric acid and salts of sulphuric acid (). Sulphur trioxide (SO_3) is generally emitted along with SO_2 at about 1 – 5% of the SO_2 concentration. SO_3 rapidly combines with moisture in the atmosphere to form sulphuric acid which has a low dew point. Both SO_2 and SO_3 are relatively quickly washed out of the atmosphere by rain or settle out as sulphate aerosols. But has a higher emission concentration if the source of pollution is from anthropogenic sources. The sulphate particles can be carried deep into the lungs, causing even more severe health problems (Ogwueleka, 2009). The effects of SO_2 on humans are unique. It causes intense irritation to eyes and respiratory tract. It is also absorbed in the moist passage of the upper respiratory tract, leading to swelling and stimulated mucus secretion. Exposure to 1ppm level of SO_2 cause a constriction of the air passage and causes significant bronchi-constriction in asthmatics at low (0.25 – 0.50ppm) concentrations. Moist air and fogs increase the SO_2 dangers due to formation of H_2SO_4 and sulphate ions. This condition is accompanied by shallow breathing and an increased respiratory rate. The acute irritant effects of the gas are confined to the upper respiratory tract where more than 95% of inhaled SO_2 is absorbed. The chronic effects resulting from extended exposure to low concentrations include incidence of respiratory infection in children (Dietert *et al*., 2000). SO_2 can also be absorbed on small particulates such as the salts of iron, manganese and vanadium present in the atmosphere and thus, enter the alveoli. SO_2 is also involved in the erosion of building materials as limestone, marble, the slate used in roofing, mortar and also deterioration of statues. From research findings, it may be considered as the most significant air pollutant due to its ability to interfere with man and nature on both micro and macro scales. About 70% of acid rains are due to SOx emissions and SOx is the main culprit in affecting human health, destroying vegetation and damaging materials and art treasures (Narayanan, 2009). Most prominent source of sulphur compounds especially H_2S are decaying vegetation and animal matter, especially in aquatic habitats. Sulphur springs, volcanic eruptions, coal pits and sewers also give off this gas. At a low concentration, H_2S causes headache, nausea, collapse, coma and finally death. Unpleasant odour may destroy the appetite at 5ppm level in some people. A concentration of 150ppm may cause conjunctivitis and irritation of mucus membranes. Exposure at 500ppm for 15 – 30min may cause colic diarrhoea and bronchial pneumonia. H_2S gas readily passes through alveolar membranes of the lung and enters the blood stream. Death occurs due to respiratory failures. The MAC for an 8-hour day is 20ppm. Everyday about one million tonne of SO_2 is released into the atmosphere from anthropogenic sources. Therefore, it become paramount to control sulphur compound pollutant which can be achieved by regular monitoring of their concentrations and the sources whether from domestic unit or with any industry generating these pollutant in Aba community. In addition, knowledge gap still exist with studies of ambient air quality at Osisioma Ngwa waste dumpsite. Hence the present work has been undertaken to study the concentrations and daily variations to sulphur compounds in the waste dumpsite at Osisioma Ngwa Local Government Area, Aba, Abia State, Nigeria.

MATERIALS AND METHODS

The research work was carried out at the waste dumpsite in Osisioma Ngwa located in Aba, Abia State, Nigeria as shown in Fig. 1.

Fig. 1: Waste Dump Site at Osisioma Ngwa (Authors field photograph 2015)

Sampling was carried out using multiple sampling points that ensures adequate coverage of the dumpsites. The designated area of the waste dumpsites at study area were selected and labelled AQSP (1), AQSP (2), AQSP (3), AQSP (4), AQSP (5), AQSP (6) and AQSP (7) as a control point. With the aid of some hard hold air quality monitors, the concentrations and daily variations of the pollutants were measured within the study area. Sampling time was within the hours of the morning and evening to get a comparative result which shows the amount of activities at the location points. A Muto Gas Analyzer Model 2002 was used to monitor the criteria pollutants, with the electrochemical measuring principles and complete gas conditioning systems. However, for the purpose of clarity within the study area, descriptive statistics was employed to present data in graph. Data in numerical and tabular form were presented and analysed using mixed effect models with random subject effect for repeated measurements. Initial analysis employed the use of linear and logistic models for the pollutants gas which was combined to know whether associations exist. The test for homogeneity in mean variance of the concentration levels of monitored gases across the sampling station was done using analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Mean values of daily concentrations and variations of SO_2 and H_2S during the morning and evening hours in dry season are presented in Table 1 and 2 below.

Table 1: Result of During Morning Hour in Dry Season.

LONG	LAT.	STATION/LOCATION	SO_2 PPM	H_2S PPM	Wind speed (m/s^2)	Elevation (m)	Temp. (^0C)	Relative humidity (%)
E007^{0}19.718	N05^{0}10.239	Umuigwe dumpsite	0.04	0.70	0.60	66	32.90	62.80
E007^{0}19.810	N05^{0}08.486	Umujima dumpsite	1.37	0.80	0.80	62	32.30	66.40
E007^{0}19.717	N05^{0}05.894	Niger stone dumpsite	1.62	3.40	0.80	57	31.80	66.40
E007^{0}19.659	N05^{0}05.320	Uratta Amaise dumpsite	0.09	0.60	0.70	57	31.40	67.60
E007^{0}18.694	N05^{0}06.981	Eyimba market dumpsite	0.13	0.10	0.90	54	32.20	96.60
E007^{0}16.913	N05^{0}18.928	Owerinta control location	0.02	0.03	0.50	25	31.00	72.40
E007^{0}19.686	N05^{0}04.414	Asaeme dumpsite	0.06	0.34	0.30	55	32.10	71.10

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E007^{0}19.810	N05^{0}08.486	Umujima dumpsite	1.52	0.30	1.70	62	31.30	57.00
E007^{0}19.717	N05^{0}05.894	Niger stone dumpsite	1.46	4.80	2.00	57	30.80	55.20
E007^{0}19.659	N05^{0}05.320	Uratta Amaise dumpsite	0.04	0.30	0.50	57	31.40	49.10
E007^{0}18.694	N05^{0}06.981	Eyimba market dumpsite	1.34	0.91	0.70	54	31.20	57.50
E007^{0}16.913	N05^{0}18.928	Owerinta control location	0.01	0.03	0.09	25	30.00	57.00
E007^{0}19.686	N05^{0}04.414	Asaeme dumpsite	0.08	0.90	0.10	55	31.10	57.10

From the result in Table 1, it is obvious that during this dry season, the concentration of sulphur dioxide at different sampled locations varied between 0.02 – 1.62ppm with Owerrinta location having the lowest sulphur value and Niger stone dump site having the highest concentration with the mean value of 0.476ppm. The concentration at the Niger Stone is suspected to be due to high volume of vehicular flow during the period. The concentration of SO_2 shown in Table 2 reveals that SO_2 concentration within the study area (at this evening hours) varies from 0.01ppm at Owerrinta to 1.52ppm at Umujima. The regional average is given at 0.645 ppm. Table 1 shows H_2S range of 0.03 to 3.40ppm for Niger Stone having 3.40ppmand and Owerrinta having 0.03ppm. The mean value is 0.853ppm. Table 2 shows concentration values of 0.03ppm for Owerrinta and Niger Stone respectively. The mean value is 1.077ppm. Wind speed in the study area varied between 0.30m/s^2 – 0.90m/s^2, having a mean value of 0.30m/s^2 in the morning (Table 1); Asaeme have the lowest value, while Eyimba has the highest value. Similarly, Niger stone has the highest of 2.00m/s^2 and Owerinta has 0.827m/s^2 with the mean value of 0.827m/s^2 in the evening (Table 2). The variations are suspected to be due to the different in locations. The elevation also varied between 25m-66m having mean value of 53.714m with Owerinta recording the lowest elevation and Umuigwe having the highest peak in the study area (Table 1). Temperature recorded in the study area during season ranged between 31^{0}C in the morning homes within the study area. Owerinta had the lowest temperature range probably due to the vegetative cover in that area, while Umuigwe had the highest temperature range both morning and evening of that period of sampling (see Table 1 and 2). Relative humidity recorded in the study area during the dry season in the morning hour ranged between 49.10-57.90% having the mean value of 55.814% with Uratta Amaise having the lowest value and Asaeme having the highest value. In the evening the wind speed varies between 0.09m/s^2 - 2.00m/s^2 Owerinta having the lowest value and Niger stone having the highest value (Table 2).

The elevation varied between 25m and 66m with mean value of 53.71m. Umuigwe recorded the highest peak in the study area (Table 2). The temperature range between 30.00^{0}C and 31.90^{0}C, with the lowest temperature recorded at Owerinta, partly because of the vegetation cover in the area. While the highest temperature range was at Umuigwe. Relative humidity recorded in the study area during morning hour in the dry season ranged between 49.10-57.500%. Mean value was recorded at 55.70% for Uratta Amaise and Eyimba market had the highest value.

Table 3: Comparison of Sampled Air Quality (dry season) with AQI Pollutants

Station	Time	SO_2	H_2S	Average AQI	Descriptive Remark
Umuigwe	Morning	0.04	0.70	86.588*	Moderate
	Evening	0.07	0.30	81.166	Moderate
Umujima	Morning	1.37	0.80	89.598*	Moderate
	Evening	1.52	0.30	91.038	Moderate
Niger Stone	Morning	1.62	3.40	89.838*	Moderate
	Evening	0.04	0.30	87.024	Moderate
Uratta Amaise	Morning	0.09	0.60	86.894*	Moderate
	Evening	0.04	0.30	87.024	Moderate
Eyimba market	Morning	0.13	0.10	79.999*	Moderate
	Evening	1.34	0.91	80.933	Moderate

Owerrinta	Morning	0.02	0.03	12.36*	Good
	Evening	0.01	0.03	13.988	Good
Asaeme	Morning	0.06	0.34	81.580*	Moderate
	Evening	0.08	0.90	77.656	Moderate

Average Air Quality Index (AQI) was calculated for morning and evening (Table 3). Average Air Quality Index for morning hours ranged between 12.36 – 89.84 and the evening hours ranged between 13.99 – 93.00 (Table 3). Comparing values with standard air quality index indicates "good" with no risk message. However, the evening average readings showed higher records than the morning average readings. This might be due to some contributory meteorological factors that has favoured the building up of the pollutant gases in the evening. The result in Table 3 obviously shows that during this dry season, the concentration of sulphur dioxide at different sampled locations varied between 0.02ppm – 1.62ppm. The mean value stood at 0.476ppm. But the World Health Organization and the Federal Ministry of Environment of Nigeria set a bench-mark standard for sulphur dioxide in the ambient air environment to be at 0.1ppm. Therefore, the value obtained at the study area is at variance with recommended standards (WHO, 2000). Human health is affected at various H_2S concentrations which include eye irritation, increase blood lactate, fatigue, loss of appetite, headache, irritability, poor memory, dizziness and respiratory distress at different concentrations (ARSDR, 2006). During the study, natural and anthropogenic sources of pollution in which the latter plays a major role. It is also concluded that apart from indiscriminate solid waste dumpsite in the area that have contributed to ambient air pollutions, other activity like vehicular flows equally plays a role, which is in line with the findings of Awomeso *et al*., (2010). As air quality monitoring system essentially measures ambient air concentrations at a number of fixed locations. In principles, the function of monitoring stations is to compare the measured values against a standard or a guideline and to take action if the measured values exceed the standard or guideline (Ugwu and Ofomatah (2011) unfortunately, in the absence of a regulated management system, too frequently no action is taken even if guidelines are exceeded. On this note, the following recommendations are made: To put in place necessary regulations that will check indiscriminate dumping of refuse through enforcement of the regulations and also the reduction of pollution levels from vehicles and refuse burning and bush burning to permissible levels as defined in national and international standards (Bishop, 2000).

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