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Passive method of monitoring and ion-chromatograpic determination of ambient sulphur dioxide in university of benin (ugbowo campus), Benin-city

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ABSTRACT

The ambient concentration of a gaseous pollutant, sulfur dioxide (SO_2) was measured in five locations in the University of Benin (Ugbowo Campus) and environ using "passive" sampling method and the sulphate sampled was measured using ion-chromatography which has been found to be very sensitive and reliable. The result obtained showed a spatial variation in concentration at various locations. The highest mean SO_2 concentration of 25.60μg/m^3 was recorded at Uniben Staff School sampling location and the lower mean concentration of 13.90μg/m^3 was also recorded at point between junior staff quarters and the kitchen complex. However, the values obtained found to be lower than WHO annual average guideline value of 50μg/m^3.

KEYWORDS

Ambient concentration;
Sulphur dioxide;
Passive ion-chromatography.

INTRODUCTION

Sulphur dioxide is the most widely distributed and important air pollutant originating from industrial and domestic combustion.

It is formed upon combustion of sulphur-containing material and thus occurs in the flue gases installations for the generating heat, vapour or electric power from sulphur containing fuels e.g. coal. It is also formed upon roasting of sulphide-containing ores. In the chemical industry, this gas is produced in the contact process for the production of sulphuric acid and occurs in the form of the residual SO_2 which is converted into SO_3.

NO_2 and SO_3 are gases that contribute to acidic deposition in terrestrial ecosystem as dry-depositional gases or in dissolved form in precipitation, fog and cloud[6]. In developed countries, SO_2 emissions depends on levels of industrialization and energy consumption, which is affected by energy intensity and efficiency.

In developing country like Nigeria, biomass burning takes place mainly, during land preparation for cultivation and by hunters to cause discomfort in original habitat of animals hunted. Detailed review of sulphur dioxide emissions from biomass has been given by Andreae[3]. However, it appears likely that biomass burning is the dominant atmospheric sulphur source in tropical latitude (25^{0}N-25^{0}S) during the burning season[5].

University of Benin, Benin City, Edo State Nigeria is located within the Niger Delta Region. Niger Delta

Region is characterized by wetland. Emissions from natural source like wetlands, oceans, volcanoes, plants and animals have been reviewed by different authors[5,2,4].

Sulphur dioxide is a strong irritant, which affects upper respiratory system and can be perceived by its odour and taste even when diluted. It is commonly understood that sluphur dioxide reduces atmospheric visibility, damages various materials and agricultural crops and is detrimental to human health. When sulphur dioxide is oxidized and hydrolyzed, it gives rise to acid rain[7]. Acid rain damages aquatic ecosystem acidifies the soil and causes forest decline.

Bearing in mind the effects mentioned above, the present study was undertaken to ascertain the ambient concentration of this ubiquitous/pollutant (SO_2) in the atmosphere of the University campus with population of over 30,000 people.

MATERIALS AND METHOD

Study area

Ugbowo Campus, University of Benin is populated with well over 30,000 inhabitants made of students and staff with their families. Four sampling locations was selected inside the university campus and one within the environ to serve as control.

SO_2 monitoring

SO_2 monitoring was carried out by using a passive sampler manufactured by Passam Ag The sampler is composed of a polypropylene housing with an opening of 20mm diameter. To reduce wind disturbance, a Teflon membrane is attached, supported by a wire net. The principle of diffusion sampler sulphur dioxide is based on diffusion of sulphur dioxide molecules onto an absorbent medium in this case a filter coated with a mixture of sodium carbonate and ethylene glycol[10]. The absorbent in the sampler selectively adsorbs atmospheric SO_2 which oxides to SO_3 and eventually SO_4^{2-}.

The tubes were exposed at a height of 1.9 metres for a period of two weeks at five locations within University of Benin (Ugbowo Campus) and environ. The samplers were harvested and taking to the laboratory for analysis.

Sample preparation and measurement

The application of classical analytical methods (such gravimetry), turbidimetry and titrimetry, various spectrophotometric and flow injection methods is usually limited by insufficient sensitivity, limiting working range or labour intensive procedures[1]. Sulphur dioxide determination in sulphate form using ion-chormatrography therefore provides sensitive, wide working range and less labour intensive procedures. Sulphate tend to be strongly adsorbed by the ion-exchange column[12].

The exposed filters of the passive samplers were put in a polyethelene vials. 5ml solution of 0.3% H_2O_2 was added and the solution extracted in a water bath. The vials were centrifuge at 4500 rpm for 10minutes. The solution was filtered through a microfilter (45μm) using a vacuum pump. Finally, Hewlett Parkard's(model HP110 series) HPLC fitted with ion-chromatography column was used to measure the sulphate ion adsorbed. Earlier, the mobile phase (element) has been prepared using sodium hydroxide mobile phase additive and acetonitrile.

RESULTS AND DISCUSSION

The result obtained is presented in TABLE 1 and 2 below. TABLE 1 shows both spatial and temporal variable of the measured SO_2 concentration. The ranges

TABLE 1 : Measured so_2 concentration during the three months of study

Code		Analysis during January	Analysis during May	Analysis during September
Uniben main gate	A	25.66	16.11	20.93
Faculty of science generating	B	26.01	17.11	21.98
Between junior staff quarters and kitchen complex	C	14.70	12.60	11.80
By the bridge linking uniben with benin - auchi road	D	26.90	23.80	19.20
Uniben staff school	E	28.88	23.02	24.90

Analysis of contents of the tube in μg/m³

TABLE 2 : Monthly mean SO_2 in μg/m³

Location	Code	Monthly mean std
Uniben main gate	A	20.90±4.8
Faculty of science generating set	B	21.70± 4.5
Between junior staff quarters and kitchen complex	C	13.90±1.49
By the bridge linking Uniben with Benin Auchi road	D	23.50±3.87
Uniben staff school	E	25.60±2.99

for the three periods studied are 28.88-40.70μg/m^3, 23.80-12.60μg/m^3 and 24.90-11.80μg/m^3.

TABLE 2 shows that in the entire period of monitoring a mean monthly SO_2 concentration range of 25.60 μg/m^3 obtained at the Uniben Staff School to 13.90μg/m^3 obtained at a point between Junior Staff Quarters and kitchen complex was recorded. Also, the TABLE shows clearly that ambient concentration of SO_2 measured in different locations varies from site to site. While site 'B' has a generation set that serves Faculty of Science incase of power outage, site 'C' is close to kitchen complex where wood is used as a source of energy to cook. Surprisingly, the site B and C recorded relatively lower SO_2 concentrations.

Site D, which is located within the University environ and is far from source of pollution recorded relatively higher SO_2 concentration. Ambient concentration of air pollutants depends on strength of the sources, efficiency of their dispersion and other meteorological conditions[11].

Depending on wind direction, wind turbulence, topography and other meteorological factors, ambient concentration of pollutant may be higher at site further than vicinity of the emission source. Therefore, the prevailing wind direction is an important factor that determines areas mostly affected by air pollution source[9]. In view of this, occupants of blocks of flats, Vice Chancellor lodge and Chancellors lodge are likely to have higher air pollution load than occupants of student's hostel, Junior Staff Quarters and part of Senior Staff Quarters.

However, annual mean values obtained were found to be lower internationally set standard of 50μg/m^3[11]. There is need to reduce or maintain this low level of SO_2 pollutant considering effect of the pollutant which includes acidic precipitation, health effect and reduction in atmospheric visibility.

CONCLUSION

Though the values recorded were below set standards both nationally and internationally, it was found to be relatively high considering very minimal presence of industries in ancient city of Benin, where the University of Benin is located. Besides SO_2 from bush burning during hunting and land clearing which is widely practiced in Benin City, it is likely that far distance source is responsibility for relatively higher SO_2 concentration monitored at different sites of the studied area.

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