

Assessment of Total Suspended Particulates (TSP) in Ikot Abasi L. G. A., Nigeria

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Abstract Concentrations of major, minor and trace elements in the total suspended particulate (TSP) matter around Ikot Abasi were determined by instrumental nuclear activation analysis (INAA) technique using the thermal neutrons from the first Nigerian nuclear research reactor (NIRR-1) at centre for energy research and training (CERT), Ahmadu Bello University, Zaria. Total suspended particulate (TSP) concentrations ranged between $139 \pm 22 \mu\text{g m}^{-3}$ and $23 \pm 07 \mu\text{g m}^{-3}$. The total TSP concentrations from different source groups revealed the commercial sector as the highest contributor of TSP level to the area with a value of $254.64 \mu\text{g m}^{-3}$. This value is slightly higher than the $\mu\text{g m}^{-3}$ standard set by the federal environmental protection agency FEPA. The INAA of the TSP samples show the presence of Al, Na and Mn. Their contributions range between $19.8 \pm 3.7 - 119.1 \pm 10.1$ ppm for Al; $57.4 \pm 10.2 - 184 \pm 16$ ppm for Na and $1.2 \pm 0.3 - 4.7 \pm 0.4$ ppm for Mn in the TSP samples around the study area.

Keywords: TSP, INAA, major, minor and trace elements

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1. Introduction

Air pollutants are responsible for vegetation injury and crop yield losses, a lot of question are being asked by concern citizens. The major threat for plant staying alive in industrial areas is air pollution. Fast growing of industries and increase toxic substances in environment are the cause of altering the ecosystem [1]. Elemental analysis of atmospheric particles has gained importance because of the effects of these particles on the environment and health [2,3]. Characterization of suspended particulate pollutants in ambient air is usually limited to estimating the quantity of total suspended particulate (TSP) matter. Although these measurements can give some indication of the general level of pollution in an area, they do not provide information concerning the elemental composition of total suspended particulate matter [4]. The elemental composition is known to differ markedly with particle size [5]. It has been observed that elements associated with natural sources, such as soil and ocean, are usually found with the coarse particulate, while elements emitted from anthropogenic sources are associated with fine particulate [6]. Fine particles are often the result of vapour conversion to liquid or solid material by the cooling of initially high temperature fumes or by chemical reactions of gases within the atmosphere. The state of the contamination of our environment has an overwhelming effect on the quality of human health. The abatement of pollution arising from various human activities has been a subject of great concern for institutions and governments. The main objective of this research is to determine the concentrations of major, minor and trace elements in the total suspended particulate (TSP) matter around Ikot Abasi L. G. A.

2. Materials and Methods

2.1. Site Selection

The TSP samples were collected around the Ikot Abasi Aluminium Smelter Plant at sites which are between 0.4 km and 18.0 km range from the Smelter Plant. Samples were collected after a reconnaissance survey where the following source types were apparent: transportation, residential, industrial, commercial, farmland and sea shore locations.

2.2. Sampling

TSP samples were collected by filtration on Whatman cellulose paper using AZTEC AS820 gravimetric high volume air sampler with Whatman filters. This filter paper has low blank concentrations for trace elements. The air sampler was placed on a wooden stand, constructed to be 1.5m high, this height is so chosen because of our interest in using the result to assess risk on human health. The filter holder was turned to face down to avoid passive dust loading. The sampling unit consists of gas pump, a filter holder, connected to the sampler by a Teflon tube. A gas flow meter with rating of 0-12 litre/min. fitted to the sampler at the beginning and at the end of sampling. Total sampling time was six hours at a flow rate of 12 litre/min. the Whatman filter papers were humidity conditioned in a desiccator for at least 48 hours and weighed continuously until a constant weight was obtained before and after sampling using Mettler (AE 240) chemical balance. The amount of TSP collected per volume of air sampled were stored in separate polythene bags and then taken to the

laboratory, where sample preparation and elemental analysis were carried out. The TSP was then determined using the relationship [7].

$$TSP = \frac{W_p}{V_{air}}$$

The weighed filter papers were folded into a polyethylene bag using forceps to avoid any contamination and heat-sealed with hot air sealer (SHENGWEI EH 28).

For elements leading to long-lived activation products, samples were packed and heat-sealed in two 7cm³ rabbit capsules and made ready for irradiation with NIRR-1. NIRR-1 is a low-power nuclear reactor, which has highly enriched uranium as fuel, light water as moderator and beryllium as reflector. A detailed description of the reactor and the irradiation facility has been given by [8].

3. Results and Discussion

Table 1 represents the summary of mean TSP obtained during the sampling period around Ikot Abasi. The TSP concentration around the ALSCON Plant within this period ranges from 23.15-162.04 µgm⁻³, with an average value of 101.35 µgm⁻³. This average value of TSP concentration around the ALSCON Plant of 101.85 µgm⁻³ is much below the 250 µgm⁻³ maximum daily average TSP sets by the national environmental pollution regulatory body, Federal Environmental Protection Agency [9]. From Table 1 the minimum TSP concentration of 23.15 µgm⁻³ was obtained at the industrial site located just 0.5 km from the ALSCON Plant while the maximum value of TSP concentration of 162.04 µgm⁻³ came from the commercial site located 10 km from the Plant.

Table 1. Mean concentration of TSP around ALSCON Ikot Abasi

Sample code	Distance from ASLCON (km)	Group	Mean conc. of TSP (µgm ⁻³)
TSPKS 01	4.00	Transportation	138.88±20
TSPKS 02	0.50	Industrial	23.15±07
TSPKS 03	6.00	Sea shore	46.30±15
TSPKS 04	5.00	Commercial	92.39±17
TSPKS 05	0.40	Sea shore	92.59±14
TSPETE 01	10.00	Commercial	162.04±22
TSPSEN 01	16.00	Transportation	92.59±13
TSPAYA 01	18.00	Farmland	115.74±18
TSPKWA 01	11.00	Residential	138.88±22
TSPKON 01	14.00	Industrial (small scale)	115.74±16

The TSP concentration of 92.59 µgm⁻³ is the same at three locations at distances of 0.4, 5.0 and 16.0 km respectively from the Plant. For the farmland sampling site located at 18.0 km from the ALSCON Plant, the TSP concentration of 115.74 µgm⁻³ is higher than the average value of TSP concentration of 69.45 µgm⁻³ obtained from the two industrial locations chosen for this work. The re-suspension of dust due to the effect of wind action on the surface soil will bring about high dust loading as recorded in this work at farmland site. A careful analysis of the result shows that commercial activities around the Ikot Abasi Aluminium Smelter Plant contribute the highest level of TSP with a total amount of 254 µgm⁻³ (Table 2). This accounted for about 25% of the total TSP concentration around the Ikot Abasi ALSCON Plant as shown in Figure 1. Closely following the commercial activity is the transportation activity which accounts for a total of 231.47 µgm⁻³ TSP concentration. The toxicity potential obtained for mean total suspended particulate matter concentration shows the degree of contamination of ambient air around the Ikot Abasi ALSCON Plant. The highest toxicity potential of 0.65 was recorded at a distance of 10 km away from the ALSCON Plant; while the lowest toxicity potential of 0.09 was recorded at 0.5 km from the Plant. These values of the toxicity potentials around the Plant are low and below the FEPA limit of 250 kg(µm³)⁻¹ (Table 3).

Table 4 shows the analytical results by INAA of elemental concentrations of the TSP at designated locations around the ALSCON Plant. From the result only three elements namely Aluminium, Sodium and Manganese were obtained from the instrumental neutron activation analysis technique. The presence of few elements in the TSP samples may be as a result of the observed low filter

loading which may be due to low flow rate of 12 litre/min or short sampling time of six hours. It could also be possible that other elements present in the sample were far below the detection limit (BDL) of INAA.

Table 2. Total TSP concentration from different source groups around ALSCON Plant

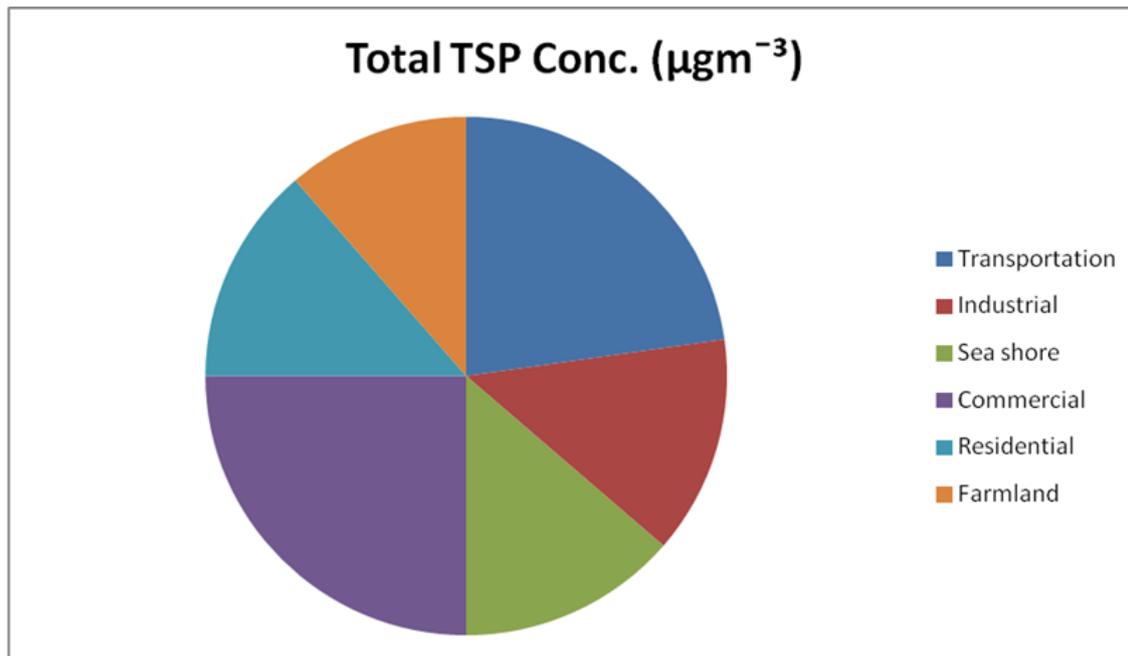
Group	Total TSP concentration (µgm ⁻³)
Transportation	231.47
Industrial	138.89
Sea shore	138.89
Commercial	254.63
Residential	138.88
Farmland	115.74

Table 3. Toxicity potential for mean total suspended particulate matter at designated locations around Ikot Abasi ALSCON Plant

Distance (km) away from ALSCON	TSP Conc. (µgm ⁻³)	Toxicity Potential
FEPA	250.00	1.00
0.40	92.59	0.37
0.50	23.15	0.09
4.00	138.88	0.56
5.00	92.59	0.37
6.00	46.30	0.19
10.00	162.04	0.65
11.00	138.88	0.56
14.00	115.74	0.46
16.00	92.59	0.37
18.00	115.74	0.46

Table 4. Analytical results of the filter samples for elemental concentration of the TSP around Ikot Abasi Aluminium Smelting Plant by INAA with NIRR-1 (values in ppm)

Element	TSPKTS01	TSPKTS02	TSPKTS03	TSPKTS04	TSPKTS05	TSPKETE01	TSPSEN01	TSPAYA01	TSPKWA01	TSPKON01
Al (ppm)	92.5±7.4	55.2±6.1	21.1±3.7	95.8±8.7	19.8±3.7	119.1±10.1	23.9±4.7	25.3±4.8	24.7±4.1	72.9±0.7
Na (ppm)	156±16	184±16	57.4±10.2	128±19	92.9±12.6	132±15	85.2±12.7	-	75.2±8.2	156±17
Mn (ppm)	-	1.9±0.4	-	4.7±0.4	BDL	1.2±0.3	-	-	-	-

**Figure 1.** Pie Chart showing the total concentration of TSP from different source group and sites around Ikot Abasi ALSCON Plant

4. Conclusion

The main objective of this work was to use INAA technique to determine the current baseline of TSP around Ikot Abasi Aluminium Smelter Plant. The heavy elements were characterized at designated locations around the plant. Commercial activities around the Ikot Abasi Aluminium Smelter Plant account for the highest TSP level of $254 \mu\text{g m}^{-3}$ or 25% of the total TSP concentration around the ALSCON Plant. This value is above the FEPA limit of $250 \mu\text{g m}^{-3}$. The highest toxicity potential of 0.65 for the mean TSP concentration was determined at a distance of 10 km away from the ALSCON Plant, while the lowest of 0.09 was measured just 0.5 km from the Plant. It is therefore recommended that places of commercial activities within Ikot Abasi should be developed in order to reduce the TSP concentration in the area. The result obtained from this work provides the baseline data for future studies around the Plant.

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