Atmospheric Level of Cadmium in Sokoto Metropolis, Nigeria.

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ABSTRACT: Reliable monitoring of atmospheric constituents is usually very technical and involves the use of sophisticated equipments. Most of these equipments are not easily accessible to many, especially in a developing country like Nigeria. Consequently, a simple sampling technique was designed to collect atmospheric cadmium in Sokoto metropolis, which was subsequently analyzed using Atomic Absorption Spectrophotometery (A.A.S). The method yielded analytically reasonable results which were in conformity with many research findings as well as international standards. The improvised technique was economical, reliable and easy to operate. The results in (ng/m^3) showed mean Cadmium concentration of 0.3±0.1. This is in agreement with the findings of WHO (1987), i.e., 1 to 5 ng/m^3 in rural areas, 5 to15 ng/m^3 in urban areas, and 15 to 50 ng/m^3 in industrialized areas .

INTRODUCTION

Cadmium has a relatively high vapour pressure. Its vapour is oxidized rapidly in air to produce cadmium oxide. When reactive gases or vapours, such as CO_2, SO_3 or $HCl_{(g)}$ are present, cadmium vapour reacts to produce $CdCO_3$, $Cd(OH)_2$, $CdSO_3$, $CdSO_4$ or $CdCl_2$ respectively. These compounds may be formed in stacks or engine exhausts and are gets emitted to the environment (WHO 1992).

Nriagu and Pacyna (1988) have estimated cadmium emissions to the atmosphere from human and natural sources on a worldwide basis. The estimates, on the basis of tones/year, are: Natural, 800 (with volcanic eruptions constituting the majority), non ferrous metal production, i.e. mining 0.6 3, zinc and cadmium 920 4600, copper 1700 3400, lead 39 195, iron and steel production 28 284, fossil fuel combustion i.e. coal 176 882, oil 41 246, refuse incineration 56 1400, sewage sludge incineration 3 36, phosphate fertilizer manufacture 68 274, cement manufacture 8.9 534 and wood combustion 60 180; the total emission being 3900 12800.

Thus, it can be seen that industries that employ thermal processes, e.g. iron production, fossil fuel combustion and cement manufacture, all release air borne cadmium, the metal being a natural constituent of the raw materials.

Municipal refuse is a waste related source, the cadmium being derived from plastics that contain cadmium pigment and stabilizers. Thus the incineration of refuse is a major source of atmospheric cadmium release. at the national, regional and world wideworldwide levels. Sewage sludge receives cadmium from industrial sources, particularly from the discharges of plating operations and pigment works. One disposal option, the incineration of sewage sludge, is a relatively minor source of airborne cadmium., reflecting the small quantities of sludge disposed in this manner. Steel production can also be considered as a waste related source, as large quantities of cadmium plated steel scraps are recycled by this industriesthese industries. in many countries. As a result, steel production is responsible for considerable emissions of atmospheric cadmium. Also, tTobacco contains cCadmium and smoking may contribute

significantly to the concentration of cadmium in air. Cigarettes may contain from 0.5 to 3μg Cd per gram of tobacco, depending on the country of origin (Elinder *et al* 1983).

Many countries carry out regular monitoring programmes for cadmium in the air. An assessment of the available data from various European countries showed that average values range from 1 to 5 ng/m^3 in rural areas, 5 to 15 ng/m^3 in urban areas, and 15 to 50 ng/m^3 in industrialized areas (WHO, 1987). In their study, Janssens and Dams (1974) foureportednd an average concentration of 1ng/m^3 and 50 ng/m^3 in the rural and urban areas of Belgium respectively. Neeb and Wahdat (1974) found), on the other hand found reported a range of 0.1-1ng/m^3 and 10-150ng/m^3 in the rural and urban areas of the fFederal rRepublic of Germany respectively. In Japan a range of 1-4 and 3-6.3ng/m^3 was found reported in the rural and urban areas respectively (JEA, 1975). In Poland, Just and Kelus (1971) found reported a range of 2-51ng/m^3 in the urban areas, while Kneip et al (2001) found reported 3-23ng/m^3 in New York. Much Higher air cadmium concentrations are found reported in areas close to major atmospheric sources of the metal. However, these values can fluctuate widely as a result of changing emission characteristics and weather conditions.

Cadmium can enter the blood by absorption from the stomach or intestines after ingestion of food, or water, or by absorption from the lungs after inhalation. Very little cadmium enters the body through the skin. Usually only about 1 to 5% of what is taken by mouth is absorbed into the blood, while about 30 to 50% of that which is inhaled is taken up into the blood. However once Cd enters the body, it is very strongly retained . Therefore, even low doses may build up to significant cadmium levels in the body if exposure continues for a long time (EBI, 2004).

Acute respiratory effects (Chemical pneumonities) may be expected at cadmium fume concentrations in air above 1 mg/m^3 (Friberg, *et al* 1974). In working environmentsenvironments where cases of acute poisoning occurred, cadmium concentrations were usually very high. For instance, in one case the fatal air concentration of cadmium oxide fume from a furnace was approximately 50 mg/m^3 for a period of about 1 hr (a dose of 2900 mg/m^3.min). In another case, the lethal dose was 2600 mg/m^3.min, i.e. a 5hr-h exposure to 8.6 mg/m^3. Friberg *et al.* (1974) estimated that an 8-hr exposure to 5to 5 mgCd/m^3 maymight well be lethal.

Chronic respiratory effects may be expected after occupational exposure to 20 μgCd/m^3 of air for about 20 years. In long-term low levellow-level exposure the kidney is regarded as the critical organ and it has been estimated that renal dysfunction may appear when the cadmium concentration in the renal cortex is around 200mg/kg wet weight (Friberg *et al,* 1974 and Friberg *et al,* 1986).

The renal accumulation of cadmium causes disturbances in the reabsorption of amino acids, glucose and minerals (CEC, 1978; and Friberg *et al,* 1974).

MATERIALS AND METHODS

Sampling

carefully Altogether ssee appendix 1 onein locations /

(a) The sampling period covered nine months starting from December (2002), January (2003), February and March during the Harmattan season through April, May and June when the summer heat was at its prime and then July and august when the rainy season

attained its maturity.

Sampling Locations:

Sokoto town, in sokoto state of Nigeria, is located at a latitude of 13° 03'N and a longitude of 5° 14'E. The sampling locations were carefully chosen to reflect the contributions of different sources in the metropolis. Altogether sSix locations were chosen within the town (see appendix 1Fig.1) and one a control location in at the permanent site of the University. The chosen locations locations are;

1. Central Bank Roundabout (A 1)
2. Maryam /Abacha Hospital Roundabout (A 2)
3. Federal Government College Roundabout (A 3)
4. Illela Garage Roundabout (A 4)
5. Dandima Roundabout (A 5)
6. Kofar Taramniya Roundabout (A 6)
7. Usmanu Dandfodiyo University Permanent Site (A 7)

(B) Sampling Train:

The sampling train has four essential elements: first, a sample line through which the air is sampled; next a device by which the pollutant under study wais collected from the air sample for analysis (e.g. a bubbler or a filter), followed by a means to measure the air volume (or flow); finally, a pump required to make maintain air flow through the system. These four elements components were usually connected together with rubber tubing.

AThe air passedin through the inverted funnel which is suspended on a wooden stand (1.5m high). It then enterspassed through a dreschel bottle(see appendix 1) containing $100cm^{3mls}$ of 5M HNO_3 where all the Cd wasin the air are qua trapped asand converted to nitrates salt. The next port is the flow meter, before getting to the pump. The gas is sampled via suction.

The idea behind this lineup is that, by inverting the funnel at a height of about 1.5m only the respirable particles would be sampled. The heavier particles would not rise to that level and therefore may not pose any serious threat to human health. Also tThe inversion would ensured that only the lighter respirable particles and gases would be able to negotiate the bend into the absorbing reagents

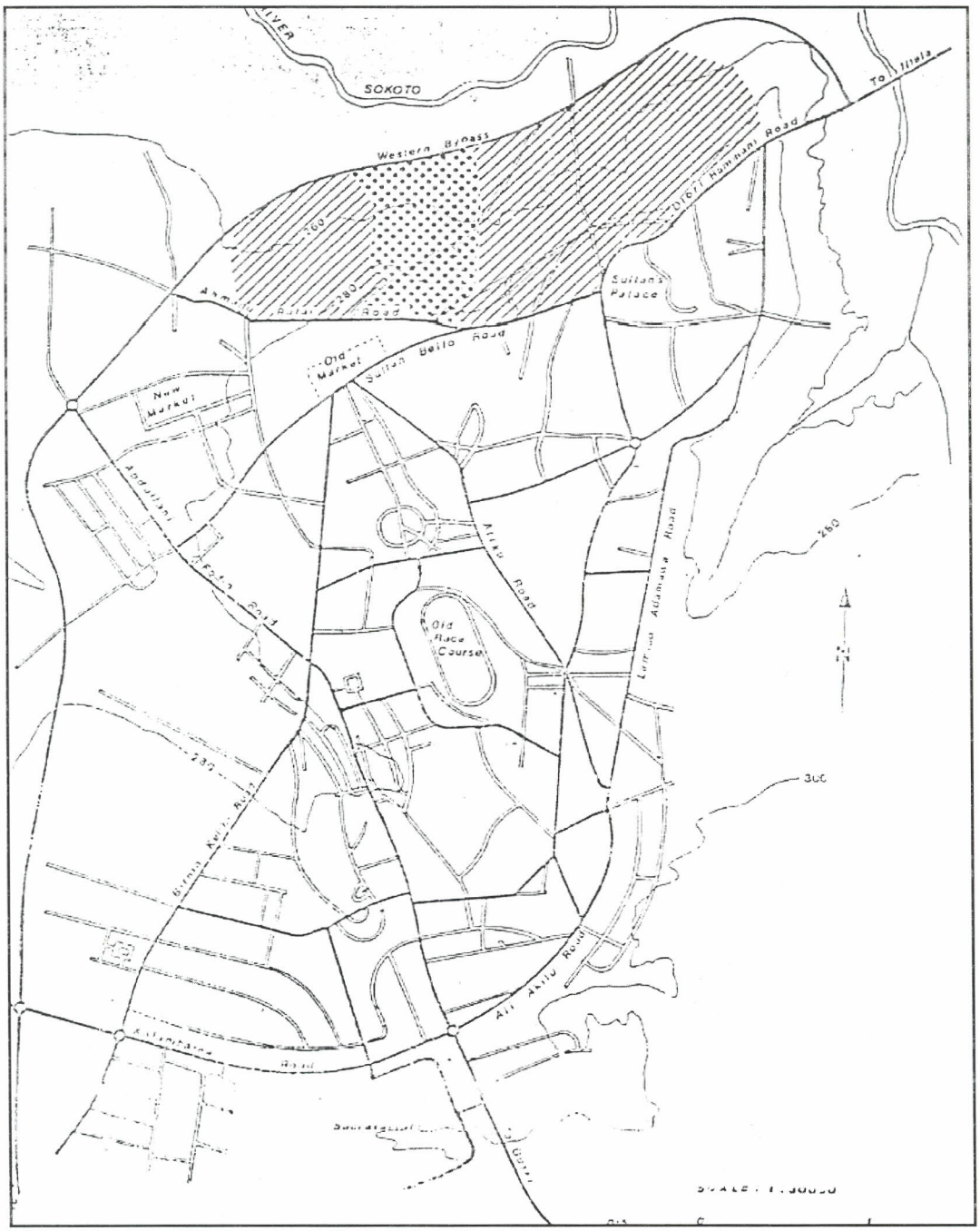

Fig.1 Map of Sokoto Metropolis Showing Sampling Locations

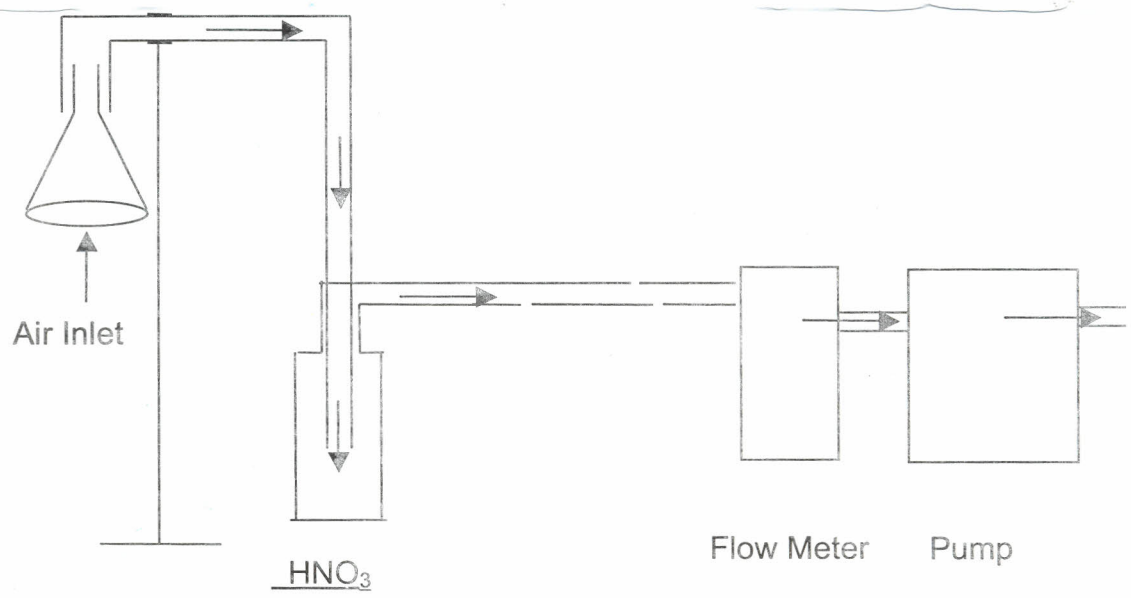

Fig2; Sampling train assembly

Analytical Procedure:

A Pye uUnicam 969 model atomic absorption spectrophotometer was allowed to stabilize and operated as per the instrument hand book. The instrument was set at the wavelength of 228.8 nm, burner height of 5 mm and slit width 7A°. theThe sample solution, blank and standard solution (series) were nebulized into blue air-acetylene flame at a flow rate of 5 cm^3/min. and a current of 5.5 mA was passed through the hallow cathodeollow cathode lamp. The corresponding concentrations (in mg/l) were recorded directly from the spectrophotometer.

The concentration of the metal in mg/lml), iwas converted to $\mu g/m^3$ using the following formula (Harrison and Perry 1986, Ademoroti 1996);

$$(\mu g/m^3) = \frac{Va \times \text{amount of element}(\mu g/cm^3 ml)}{V}$$

Where Va is the volume of absorbing solution (100 cm^3mls).
V is the volume of air in litres at 1 atmosphere and 25 °C

RESULTS AND DISCUSSION

Cadmium (Cd):

The average level of 0.3 ng/m^3 cadmium observed is below the range of 2.1- 7.2 g/m^3 reported by Chorazy *et al.* (1994), but is in agreement with the findings of WHO (1987), i.e., 1 to 5 ng/m^3 in rural areas, 5 to15 ng/m^3 in urban areas, and 15 to 50 ng/m^3 in industrialized areas of various European countries. The same can be said about the findings of Janssens and Dams (1974), with an average of 1 ng/m^3 and 50 ng/m^3 in the rural and urban areas of Belgium respectively. Other ranges that are in agreement with the findings of this work are that of Neeb and Wahdat (1974) who reported ranges of 0.1-1 ng/m^3 and 10-150 ng/m^3 in the rural and urban areas of the Federal Republic of Germany respectively. Just and Kelus (1971) in Poland, reported a range of 2-51 ng/m^3 in the urban areas and Kneip *et al* (2001) reported a range of 3-23 ng/m^3 in New York. JEA (1975) also found a range of 1-4 and 3 - 6.3 ng/m^3 in the rural and urban areas of Japan respectively. However, the level is above the 5x 10^{-4} ng/m^3 background level reported by ATSDR (2005).

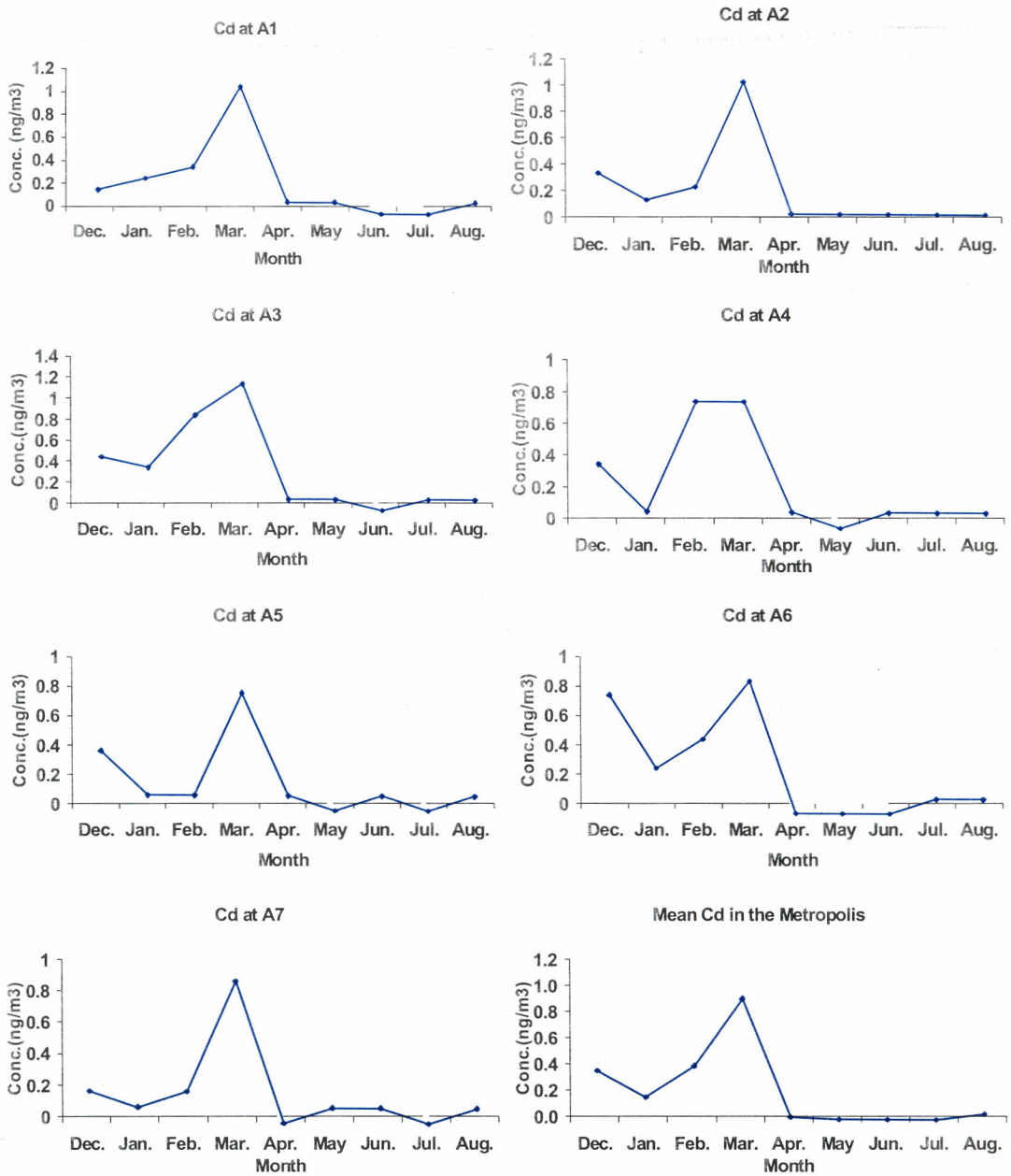

Fig.3: Plots of Cadmium concentration at the various locations.

The F-value for the means of cadmium concentration across the locations showed that $F_{Cal.} < F_{Tab}$. This means that there is no significant difference between the means. However, when the same treatment is done on the means across the months, it is observed that $F_{Cal.} > F_{Tab}$ indicating significant difference between monthly means.

From the concentration plots in Fig.3, it is clear that cadmium concentration is higher between the months of February and March in all the locations. This can be attributed to contributions from Harmattan dust. That is why in almost all the locations the level is higher in December, before coming down in January (which may be the usual break in Harmattan) but started rising in February, reaching its highest in March.

However, looking at the concentration plot in A1, it can be concluded that traffic or fossil

fuel combustion (see A7 as well) is not the major source of atmospheric Cd in the metropolis. At A2, a steady level is observed after the harmattan period (ie, April through August) because of the scrap recycling and pot fabrication earlier suggested.

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