International Journal of Earth, Energy and Environmental Sciences
ISSN: 2517-942X
Vol:8, No:7, 2014

Zinc Contaminate on Urban Roadside in Rush Hour, Bangkok, Thailand

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***Abstract*—**This research aims to study the Zinc (Zn) concentration in fine particulate matter on Rajchawithee roadside in rush hour. 30 Samples were collected in Jun to August 2013 by 8 stage non-avaible cascade impactor. Each samples (filter paper) were digest with nitric acid and analyed by atomic absorption spectrophotometer for Zinc determination. The highest value for the mean fraction (18.00 ± 9.28%) is the size 9.0 – 110.0 micron follow by the range 3.3 – 4.7 micron (14.77 ± 14.66 %) and 1.1 – 2.1 micron (14.01 ± 11.77 %). The concentration of Zn in the particulate matter of range 0.43 – 0.7µm, 0.7 – 1.1 µm, 1.1 – 2.1 µm, 2.1 – 3.3 µm, 3.3 – 4.7 µm, 4.7 – 5.8 µm, 5.8 – 9.0 µm, 9.0 – 10.0 µm, were 41.56 – 217.62 µg/m^3 (175.86 ±32.25 µg/m^3), 152.60 – 217.24 µg/m^3 (187.71 ± 17.42 µg/m^3), 142.90 – 214.67 µg/m^3(180.95 ± 18.71 µg/m^3), 155.48 – 218.19 µg/m^3(183.22 ± 19.94 µg/m^3), 151.72 – 217.39 µg/m^3(181.85 ± 17.57 µg/m^3), 133.86 – 220.17 µg/m^3 (178.78 ± 23.45 µg/m^3), 160.00 – 220.35 µg/m^3 (182.58 ± 18.08 µg/m^3), 153.30 – 226.70 µg/m^3 (181.52 ± 20.05 µg/m^3), respectively. The Zn concentration in each size of particulate matter was not statistically significant different (p > .005)

***Keywords*—**Air Pollution, Air Quality, Pollution and monitoring.

I. Introduction

BANGKOK is the capital and the most populous city in Thailand. It has a population of over 7.8 million inhabitants in an area of approximately 1,500 km^2 [1]. The city is congested with a large number of motor vehicles. More than 5.9 million vehicles circulate within the city in 2008 [2]. Traffic has been the main source of air pollution in Bangkok.

Bangkok (latitude 13°45'N, longitude 100°29'E) (Fig. 1) is the Capital and the most populous city in Thailand. It has a population of over 5.6 million inhabitants in an area of approximate 1,500 km^2. The city is congested with a large number of motor vehicles. More than 5.9 million vehicles circulate within the city in 2008. Traffic has been the main sources of air pollution in Bangkok.

In the pass several investigations have been made on the measurement of size distribution of particulate matter and associated element concentration in urban area.

The particulate matter in the urban ambient air is an important issue. It can be deep into the respiration system. Traffic is important source of particulate matter. Knowledge related to the size distribution of small particulate matter, elements and contaminants in particulate matter is important because it effects the health of those who breath the particulate matter into the respiratory system.

Urban air pollution resulting from traffic is a major problem in Bangkok, Thailand.

Fig. 1 Dusit District, Bangkok, Thailand [3]

Major of air pollutant from traffic is particulate matter and carbon monoxide which is released from the exhaust of the vehicle. Traffic particulate matter come from 2 sources. The fine particulate matter comes from diesel exhaust. And other source come from non – exhaust, it come from tire wear and break, that particulate matter contaminate with Zinc. [4] Emission due to road traffic is known to make a large contribution to particulate matter concentration in urban area. Particulate matter emissions from road vehicles include emissions from exhaust and non- exhaust (such as brake, tyre, cluth and re-suspension of dust. It is estimated that nearly 90% of the total emissions from traffic will come from non-exhaust source. [5] Fine particulate matter come from non-

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exhaust, it come from tire wear and break, that particulate matter contaminate with zinc.[4]

Non – exhaust particulate matter are generated due to brake and tyre wear, road surface abrasion wear and tear corrosion of other components such as the cluth and re-suspension of road surface dust. The fine particulate matter found that Ba, Zn and Pb. [6]

Tyre tread, a source of particulate matter, contains natural rubber copolymers such as styrene – butadiene rubber and polyisoprene rubber, and zinc is add to tyre tread as zinc oxide and organozinc compounds. To facilitate the vulcanization process passenger car tyres in EU are known to contain nearly 1% zinc oxide. [7]

Zinc is reported to be nearly 1% by weight in rubber tyres anf tyres were has been reported to be significant source of Zn. [8]

Source of zinc in relation to automobile traffic are: wearing of brake lining, losses of oil and cooling liquid, wearing of road paved surface, wearing of tyres, and corrosion of galvanized steel safety fence and other road furniture. [9]

The study area chosen for the present study, "Bangkok, Thailand" aims to: (1) determine the mass concentration with difference size fractions of PM_{10} (2) determine the Zinc (Zn) concentration with difference size fractions of PM_{10}

The human respiratory tract is an aerodynamic classifying system for airborne particles. The impactor is designed as a substitute for the human respiratory tract to collect and separate particulate matter according to its aerodynamic size and property (show in Fig. 2). The fraction of inhaled particles retained in the human respiratory system and the site of deposition vary with size, shape, density and all physical properties of the particles that constitute aerodynamic dimensions. Because the human lung penetration curves are known to be of unit density spherical particles. The Impactor has been characterized and tested for particle size separation (cut-point). Therefore as long as a standard model of the Impactor is used according to standard laboratory operating procedures, the individual Impactor Stage distribution of collected particle mass will indicate the extent to which the aerosol sampled would have penetrated the human respiratory system. This information is vital to environmentalist, aerosol physicists and industrial hygienists for determining health risk and epidemology.

II. Materials and Methods

A. Sampling Area Description

All samples were collected in the Dusit District (Fig. 1), where located at central of Bangkok. This district is the main administrative centre of the kingdom, as both the national Assembly and royal palace are located in this district.

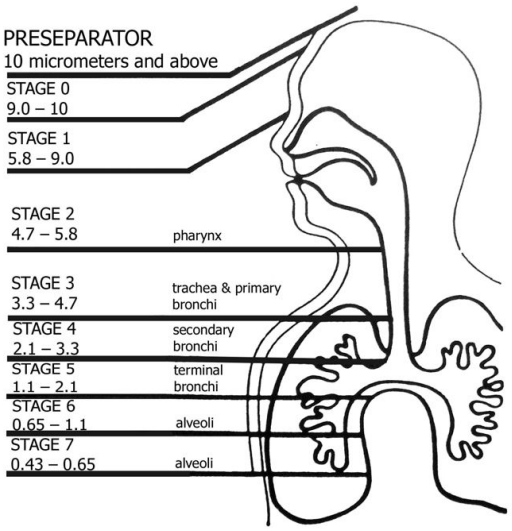

Fig. 2 The human respiratory is an aerodynamic classifying system for airborne particles [10]

B. Sampling

Samples were collected on Ratchawithee roadside (traffic flow as 16,439 vehicles per day) in rush hour. 30 samples were collected about 3 hr. on Ratchawithee roadside in rush hour (6.00–10.00 am.). This sample was collected on re–weighed glass fibre filters. Each set of samples consists of eight different size filters for various size ranges. The Eight Stage non- Aiable Cascade Impacter (Tisch Environment, USA.) was used at an average flow rate of 28.3 l/min. This sampler segregates particulate matter in the following size ranges: Stage 1: 0.43–0.7 micron, Stage 2: 0.7– 1.1 micron, Stage 3: 1.1–2.1 micron, Stage 4: 2.1–3.3 micron, Stage 5: 3.3–4.7 micron, Stage 6: 4.7–5.8 micron, Stage 7: 5.8 –9.0 micron and Stage 8: 9.0–10.0 micron .

The filters were kept in dessicators for 24 hrs. (to remove any moisture content be for mounting them on the air sampler). After sampling, filter papers were immediately transferred to dessicators to again de- moisturize them in the same manner.

Fig. 3 Eight Stage non- Aviable Cascade Impacter

Fig. 4 Atomic Absorption Spectrophotometer Instrument (THERMO series)

C. Standard, Reagent and Blank.

The primary standards for AAS were obtained from high purity metals or salts dissolved in high purity acids. The blanks of the filters were evaluated by analyzing in the same method as the samples.

D. Analysis

After sampling and reweighting, the filters were cut to 200 mm x 250 mm. Each filter was digested in 20 ml of concentrated nitric acid at 150-200°C for 2 hrs. [11] and then diluted to 25 ml. with distilled deionized water. A THERMO series atomic absorption spectrophotometer (Fig. 4) was used to measure the trace metal concentration. The concentration of heavy metal was calculated by (1) [12]:

$$C = \frac{25 \times A \times B}{D \times V} \quad (1)$$

when

C is heavy metal concentration ($\mu g/m^3$)
25 is final volume before analyze by AAS (ml)
A is the total area of filter (m^2)
B is the heavy metal concentration from AAS (mg/l)
D is the area of filter were cut (m^2)
V is the total value of air were collected (m^3)

E. Quality Control

Background contamination was routinely monitored by using operational blanks (unexposed) which processed simultaneously with field samples. In this study, the background contamination is insignificant and can be ignored. At least 10% of the samples were analyzed by spiking with metal to calculate the recovery efficiencies. The ranges of recovery efficiency tests indicated the ranged of recovery efficiency among every 10 samples varied between 95% and 102%. The reproducibility test varied between 98 % and 105% for all chemical species.

III. Result and Discussion

A. Particulate Matter Concentration

Tables I–III show the characteristic of the concentration distribution in the eight range of particulate matter. The highest value for the mean fraction (18.00 ± 9.28%) is the size 9.0–110.0 micron follow by the range 3.3–4.7 micron (14.77 ± 14.66 %) and 1.1–2.1 micron (14.01 ± 11.77 %). The concentration of Zn in the particulate matter of range 0.43 – 0.7μm, 0.7–1.1 μm, 1.1–2.1 μm, 2.1–3.3 μm, 3.3–4.7 μm, 4.7–5.8 μm, 5.8–9.0 μm, 9.0–10.0 μm, were 41.56–217.62 $\mu g/m^3$ (175.86 ± 32.25 $\mu g/m^3$), 152.60–217.24 $\mu g/m^3$ (187.71 ± 17.42 $\mu g/m^3$), 142.90–214.67 $\mu g/m^3$ (180.95 ± 18.71 $\mu g/m^3$), 155.48–218.19 $\mu g/m^3$ (183.22 ± 19.94 $\mu g/m^3$), 151.72 –217.39 $\mu g/m^3$ (181.85 ± 17.57 $\mu g/m^3$), 133.86–220.17 $\mu g/m^3$ (178.78 ± 23.45 $\mu g/m^3$), 160.00–220.35 $\mu g/m^3$ (182.58 ± 18.08 $\mu g/m^3$) and 153.30–226.70 $\mu g/m^3$ (181.52 ± 20.05 $\mu g/m^3$), respectively.

TABLE I
THE PARTICULATE MATTER AND ZINC CONCENTRATION

Particulate Matter Size (micron)	n	Particulate Matter Concentration (μgm^{-3})	
		range	Mean ±SD
0.43 – 0.7	30	2.0 – 156.5	33.4 ± 33.4
0.7 – 1.1	30	2.0 – 335.0	47.3 ± 59.7
1.1 – 2.1	30	6.0 – 395.2	70.9 ± 92.1
2.1 – 3.3	30	2.0 – 176.5	39.1± 40.6
3.3 – 4.7	30	4.0 – 703.2	89.7 ± 134.4
4.7 – 5.8	30	2.0 – 961.1	95.7 ± 172.2
5.8 – 9.0	30	2.0 – 312.9	57.5 ± 65.5
9.0 – 10.0	30	6.0 – 429.3	80.4 ± 82.4

TABLE II
THE PARTICULATE MATTER AND ZINC CONCENTRATION

Particulate Matter Size (micron)	n	Zn Concentration (μgM^{-3})	
		range	Mean ±SD
0.43 – 0.7	30	41.56 – 217.62	175.86 ±32.25
0.7 – 1.1	30	152.60 – 217.24	187.71 ± 17.42
1.1 – 2.1	30	142.90 – 214.67	180.95 ± 18.71
2.1 – 3.3	30	155.48 – 218.19	182.33 ± 19.94
3.3 – 4.7	30	151.72 – 217.39	181.85 ± 17.57
4.7 – 5.8	30	133.86 – 220.17	178.78 ± 23.45
5.8 – 9.0	30	160.00 – 220.35	182.58 ± 18.08
9.0 – 10.0	30	153.30 – 226.70	181.52 ± 20.05

TABLE III
THE PARTICULATE MATTER DISTRIBUTION

Particulate Matter Size (micron : μm)	n	Particulate Matter Distribution (%)	
		range	Mean ±SD
0.43 – 0.7	30	0.21 – 28.57	9.16 ± 6.79
0.7 – 1.1	30	0.66 – 21.57	10.26 ± 5.94
1.1 – 2.1	30	1.05 – 59.55	14.01 ± 11.77
2.1 – 3.3	30	0.69 – 19.62	8.83 ± 5.33
3.3 – 4.7	30	1.24 – 73.01	14.77 ± 14.66
4.7 – 5.8	30	0.62 – 53.49	12.86 ± 10.01
5.8 – 9.0	30	1.06 – 41.61	12.12 ± 8.47
9.0 – 10.0	30	1.05 – 34.18	18.00 ± 9.28

The characteristic of the concentration distribution in the eight ranges of particulate matter. The highest value for the mean fraction (18.00 ± 9.28 %) is the size 9.0–110.0 micron follow by the range 3.3–4.7 micron (14.77 ± 14.66 %) and 1.1 –2.1 micron (14.01 ± 11.77 %). The Zn concentration in each size of particulate matter was not statistically significant different ($p > .005$).

IV. Conclusion

The highest value for the mean fraction (18.00 ± 9.28 %) is the size 9.0–110.0 micron follow by the range 3.3–4.7 micron (14.77 ± 14.66 %) and 1.1–2.1 micron (14.01 ± 11.77 %). The Zn concentration in each size of particulate matter was not statistically significant different ($p > .005$).

Acknowledgment

The financial support was provided by the Research and Development Institute, Suan Sunandha Rajabhat University.

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