Chemical speciation of Zn in roadside deposited dust of Asansol, West Bengal, India

Article · November 2015

CITATIONS
0

READS
62

3 authors:

Manash Gope
National Institute of Technology, Durgapur
20 PUBLICATIONS **220** CITATIONS
SEE PROFILE

Raza Rafiqul Hoque
Tezpur University
47 PUBLICATIONS **846** CITATIONS
SEE PROFILE

Srinivasan Balachandran
Visva- Bharati
50 PUBLICATIONS **1,183** CITATIONS
SEE PROFILE

INTERNATIONAL JOURNAL OF BIO-RESOURCE, ENVIRONMENT AND AGRICULTURAL SCIENCES (IJBEAS)
Vol. 1(4) :192-198, 2015
www.sbear.in // ISSN 2454-3551

CHEMICAL SPECIATION OF ZN IN ROADSIDE DEPOSITED DUST OF ASANSOL, WEST BENGAL, INDIA

Manash Gope[1], Raza Rafiqul Hoque[2] and S. Balachandran[1]*

[1]Department of Environmental Studies, Siksha-Bhavana, Visva-Bharati,Santiniketan- 731 235, Birbhum, West Bengal, [2]Department of Environmental Studies, Tezpur University, Tezpur-784028, Assam.
*Correspondence to: s.balachandran@visva-bharati.ac.in
Received: October 2015 Revised accepted: November 2015

ABSTRACT

One of the well known industrial belts of West Bengal is Asansol. Due to its industrial importance, densely populated as well as the traffic density is also considerably high. Street dust is one of the important indicators that reflect the status of urban environmental pollution.Prevalence ofheavy metals like Zinc(Zn) in road side dust,released from industries and traffic is always of serious environmental concern.The determination of chemical speciationof Zinc collected from national highway, residential areas, busy traffic areas and industrial areas of Asansolin the present study providesan important input into the labile nature as well as their possible impacts on health and environment.Sequential extraction procedure was used for chemical speciation of Znin street dust samples of <53 μm fraction size. The metal concentration was analyzed by ICP-AES. From the results Zn was found to be in following sequence:Organic matter (59%) > Carbonates (15%) > Exchangeable (13%) > Residual (7%) > Fe-Mn oxide (6%) fraction.The Contamination Factor (CF) and Enrichment Factor (EF) indicate that street dust collected from national highway of Asansolhas been extremely high contaminated by Zn.

Keywords: Zinc, Street dust, Sequential extraction procedure, ICP-AES, Chemical speciation,

INTRODUCTION

Migration of people to towns and cities in search of better lifestyle has progressed very rapidly all over the world. Urbanization adversely affects the quality of the environment. Due to urbanization and industrialization large amount of heavy metals are released into the environment. The heavy metal content in road dust particles has been used to reflect the degree of the environment contamination (Beckwith et al., 1985; Fergusson and Kim, 1991; Ogunsola et al., 1994; Stone and Marsalek, 1996; Al-Rajhi et al., 1996; Massadeh and Snook, 2002; Jaradat, 2002; Massadeh et al.,2007).Moving vehicles, construction, industries emission, atmospheric fallout, use of fertilizer are the main sources of deposited contaminants on roadway surface (Chen et al., 2001, Massadehet al.,2007). Soil serves as a sink and as a source for heavy metals (Krishna and Govil 2005; Li et al., 2009; Mahanta and Bhattacharya, 2011). So street dust also serve as a source and sink of heavy metals, and monitoring of street dust plays a great role in assessing environmental quality.It is generally believed that metals are associated with smaller grain size particles and smaller particles have larger specific surface area and therefore contain higher concentration of metals (Singh, 2011). The potential health effects due to exposure, inhalation, and dermal contact of road dust depends upon size of dust particles, rate of deposition, rate of transfer to the human organism, chemical composition of dust

etc.(Singh,2011). So, a study was undertaken for a thorough understanding of Zn content and its speciation transformation, studying the environmental behavior Zn in Asansol with the following objectives: a) determining total concentration of heavy metals Zn in street dust b) assess the solid phase fractionation of Zn in street dust, c) to assess the degree of contamination of Pb and Cd by various geo statistical techniques like Contamination Factor (CF)andEnrichment Factor (EF) in street dust from different anthropogenic activities.

MATERIALS AND METHODS

Study area

Asansol is one of the densely populated cities of West Bengal, which have small and large industries and high traffic densitythroughout day and night as it is situated in Grant Trunk road.Moreover Kolkata is connected with Asansol by National highway from one side and on other side Dhanbad is also connected.

Collection of Samples

A total 8 roadside dust samples were collected from different area with different activities (Table 1). At each sampling point, roadside dust samples were collected along major roads near the busy traffic, industrial area and residential areas using a plastic brush and tray. Any obvious extraneous matters such as cigarette ends or other debris etc. were not collected with the sample and each brush was used once only before giving a thorough cleaning (Anju and Banerjee, 2003).

Table 1: Name and type of location of sampling sites

Sample No.	Location	Location type
1	Kalipahari bus stoppage	National highway
2	Near Ghagarburi Temple	National highway
3	Ushagram Busy	Traffic
4	Hutton Road(main bus stand)	Busy Traffic
5	Mohishila Colony	Residential Area
6	Vivekananda palli	Residential Area
7	Radhanagar	Industrial area
8	Scop gate	Industrial area

Sequential Extraction Procedure

The sequential extraction procedure of Tessier et al. (1979) was used for the extraction and partitioning of Zn in the street dust into five fractions, viz., exchangeable (*F1)*, bound to carbonate phase (*F*2*)*, bound to

iron and manganese oxides (*F*3*)*, bound to organic matter and sulfides (*F*4*)*, and residual or lattice metals (*F*5*)* in this study.For analysis 2.0 g of air dried homogenized dust sample of ≤ 53µm diameter particle size was subjected to various leaching treatments to separate the Zn into the five operationally defined fractions. After each step the mixture was centrifuged at 6000 rpm for 1 hr(Remi instruments) Sequential extractions were done with duplicate samples.

Analysis

After digestion with Tessieret al.(1979) procedure modern instrumental analytical method such as inductively coupled plasma-atomic emission spectrometry(ICP-AES) has been used for the determination of Zn concentration in street dust samples.

Contamination Factor (CF)

The level of contamination of soil by metal is expressed in terms of a contamination factor (CF) calculated as:

$$CF = \frac{CmSample}{CmBackground}$$

Where the contamination factor CF < 1 refers to low contamination; 1 ≤ CF < 3 means moderate contamination; 3 ≤ CF ≤ 6 indicates considerable contamination and CF > 6 indicates very high contamination (Tomilson et al.,1980; Chakravarty and Patgiri, 2009; Seshan et al.,2010).

Enrichment Factor (EF)

EF can be used to evaluate the magnitude of contamination of metals in the Road dust. EF was computed following the equation proposed by (Zoller et al., 1974; Lehame et al., 1992)

$$EF = (C_M/C_{Fe})_{sample}/(C_M/C_{Fe})_{Earth's\ crust}$$

EF < 2: Deficiently to minimal enrichment

2 ≤ EF < 5: Moderate enrichment

5 ≤ EF < 20: Significant enrichment

20 ≤ EF < 40: Very high enrichment

EF ≥ 40: Extremely high enrichment

Where, $(C_M/C_{Fe})_{sample}$is the ratio of concentration of trace metal(C_M) to that of Fe (C_{Fe}) in street dust sample and $(C_M/C_{Fe})_{Earth's\ crust}$is the same reference ratio in the Earth crust. The average abundance of Zn and Fe in the reference Earth's crust were taken from Taylor (1964). Fe was taken as a reference element because of its immobility and crustal abundance.

RESULT AND DISCUSSION

Total Metal concentration for Zinc in eight sampling sites of Asansol is shown in Table 2. Foreign materials such as small gravel, waste plastics, metal scraps, and demolished construction debris were

observed in the street dust, indicating that the street dust in the sampling site was strongly affected by anthropogenic activities (Mahanta and Bhattacharyya, 2011). Enrichment Factor (EF) and Contamination Factor (CF) of Zn in sampling sites of Asansol are also shown in Table 2. Here we also measured Iron(Fe) concentrations of same sampling sites of Asansol to determine the Enrichment Factor and Contamination Factor.

Table 2. Total concentration, Enrichment Factor and Contamination Factor of Zn

Site	Zn(µg/gm)	EF of Zn	CF for Zn
Site 1	544.17	17.91	7.77
Site 2	497.66	12.65	7.11
Site 3	507.26	13.84	7.25
Site 4	671.78	25.42	9.60
Site 5	205.65	7.39	2.94
Site 6	291.28	12.46	4.16
Site 7	352.53	7.33	5.04
Site 8	334.60	6.00	4.78

The highest Zinc concentration was found in site 4 which is the main bus stand of the city. Zn concentrations were low in residential areas and the lowest concentration is associated with Site 5. Site 4 has the maximum Zn concentration compare to other sites and this is because of heavy traffic load. Wear and tear of tire, break shoe etc, leads to deposition of Zn in the environment. Enrichment Factor and Contamination Factor also showed that site 4 has got very high contamination. The present study shows that industrial sites have got only significant enrichment. Residential sites have moderate enrichment and contamination. So except residential sites all sites have very high Zn contamination.

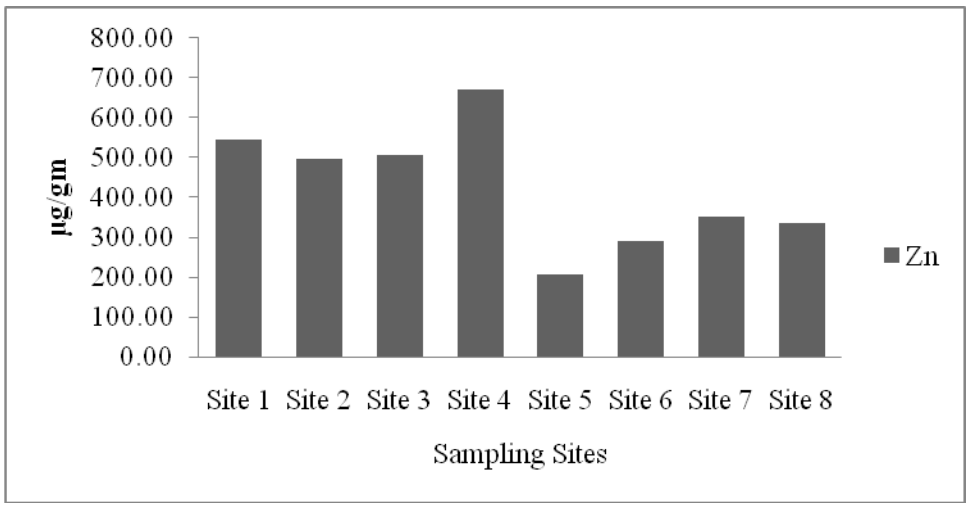

Fig. 1: Total Zn concentration in roadside deposited dust of eight sites of Asansol

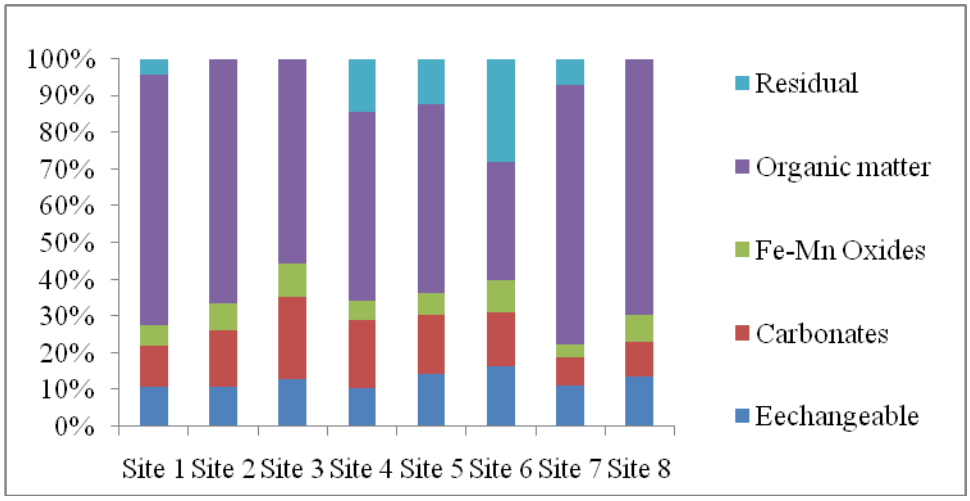

Fig. 2: Partitioning of Zn in five fraction in the road dust (<53 µm)

The sequential extraction procedure showed that zinc is strongly associated with Organic matter fraction (*F*4*)* to the extent of 59% and the carbonates (*F*2*)* by 15%. Zn in the exchangeable fraction (*F*1*)* accounts for 13% of the total Zn in the soil which is the most bio-available fraction. The residual fraction (*F*5*)* also holds another 7% of the total Zn. The Fe-Mn oxides (*F*3*)* acconutsfor only only 6% of Zn. So the percentage of mobile portion of Zn is not in higher side. So mostly immobile fractions i.e. residual and organic matter holds maximum concentration of Zn.If favourable conditions like anoxic, acidic environment occur then Zn can be leached out as bioavailable form which might affect environment.

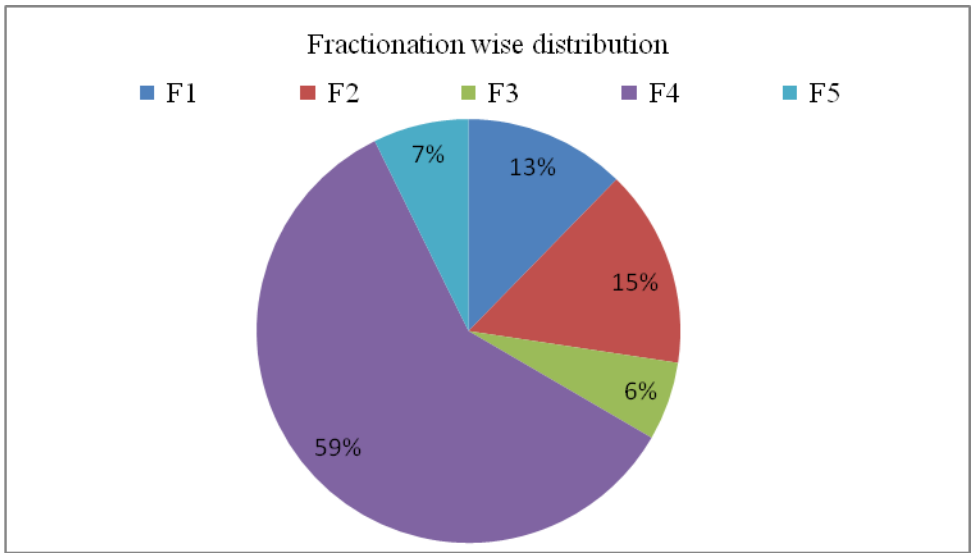

Fig. 3:Fractionation wise distribution of Zn in all sites of Asansol.

CONCLUSION

The present study assessed that Asansol is significantly polluted with Zn. The variation in result in all sites reflects the role of anthropogenic activity. The total as well as fractional concentrations of Zn in urban street dust belonging to four different types of land use. All types of land use hold Zn in considerable amount of Zn and leads to contamination.

REFERENCES

Singh, A. K. 2011. Elemental chemistry and geochemical partitioning of heavy metals in road dust from Dhanbad and Bokaro regions, India. *Environ Earth Science* 62:1447-1459.

Al Rajhi, A., Seaward, M.R.D. and Al-Aamer, A. S. 1996. Metal levels indoor and outdoor dust in Riyadh, Saudi Arabia. *Environment International* 22(3): 315-324.

Anju and Banerjee, D. K. 2003. Heavy metal levels and solid phase speciation in street dusts of Delhi, India. *Environmental Pollution* 123: 95-105.

Beckwith P., Ellis, J.B. and Revitt, D.M. 1985. Particle size distribution of Cu, Pb and Zn across a road surface.*In: Heavy Metals in the Environment*, CEP, Edinburgh 1:174-176.

Chakravarty, M. and Patgiri, A. D. 2009. Metal pollution assessment in sediments of the Dikrong River, NE India. *J. Hum. Ecol.* 27 (1): 63-67.

Chen, B., Shand, C. A. and Beckett, R. 2001. Determination of total and EDTA extractable metal distributions in the colloidal fraction of contaminated soils using SdFFF-ICPHRMS. *Journal of Environmental Monitoring* 3: 7-14.

Fergusson, J. E. and Kim, N. D. 1991. Trace element in street and house dusts: sources and speciation. *Science of Total Environment* 100: 125-150.

Jaradat, Q. M., Massadeh, A. M., Zaitoun, M. A. and Maitah, B. 2006. Fractionation and sequencial extraction of heavy metals in the soil of scrap yard of discarded vehicles. *Environmental Monitoring and Assessment* 112: 197-210.

Jaradat, Q. M. 2002. Fraction and distribution of heavy metals in street dust in Amman. *Jordan Mu'tah Lil-Buhuth wad-Dirasat* 17(3): 105-118.

Krishna, A. K. and Govil, P. K. 2005.Heavy metal distribution and contamination in soils of Thane-Belapur industrial development area, western Indian. *Environmental Geology* 47: 1054-1061.

Lehame, S., Charleshorth, D. and Chowdhry, B. 1992. A survey of metal levels in street dusts in an inner London neighborhood. *Environ. Int*. 18: 263-270.

Li, F., Fan, Z., Xiao, P., Oh, K., Ma, X. and Hou, W. 2009.Contamination, chemical speciation and vertical distribution of heavy metals in soils of an old and large industrial zone in Northeast China.*Environmental Geology* 57:1815-1823.

Massadeh, A., Jaradat, Q. and Obiedat, M. 2007. Chemical Speciation of Lead and Cadmium in Different Size Fractions of Dust Samples from Two Busy Roads in Irbid City, Jordan. *Soil & Sediment Contamination* 16:371-382.

Massadeh, A. M. and Snook, R. D. 2002. Determination of Pb and Cd in road dusts over the period in which Pb was removed from petrol in the UK. *Journal of Environmental Monitoring* 4: 567-572.

Ogunsola, O., Ouluwole, A., Asbiojo, O., Olaniyi, H., Akeredolu, F., Akanle, O., Spyrou, N.,Ward, N., and Ruck, W. 1994. Preliminary elemental characterization of roadside dust in Lagos, Nigeria. *Science of Total Environment* 146(147): 175-184.

Seshan, B. R. R., Natesan, U. and Deepthi, K. 2010. Geochemical and statistical approach for evaluation of heavy metal pollution in core sediments in southeast coast of India. *International Journal of Environmental Science and Technology* 7 (2): 291-306.

Stone, M., and Marsalek, J. 1996.Trace metal composition and speciation in street dust. *Journal of Environmental Quality* 97: 151–168.

Taylor, S. R. 1964. Abundance of chemical elements in the continental crust: a new table *Geochimicaet Cosmochimica Acta* 28: 1273-1285**.**

Tomilson, D. C., Wilson, D. J., Harris, C. R. and Jeffrey, D. W. 1980. Problem in assessment of heavy metals in estuaries and the formation of pollution index. *Helgol.Wiss.Meeresunlter* 33 (1-4): 566-575.

Zoller, W. H., Gladney, E. S. and Duce, R. A. 1974. Atmospheric concentrations and sources of trace metals at the South Pole. *Science* 183:198-200.