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Characterization of Ambient Respirable Particulate for Toxic Metals in an Urban City

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In recent years, presence of fine particulate associated with toxic metals in the air environment of urban cities have received an increasing amount of attention. These particulates of toxic metals persists in the atmosphere for longer duration and can easily be inhaled by human respiratory systems. The recent studies have reported that road transport to be a major source of Respirable Suspended Particulate Matter (RSPM) with other significant contribution from power plant, combustion plant process and non–combustion process in addition to road dust (Chow et al.,1992). Various epidemiological studies have proved that exposure to fine particulate matter associated with toxic metals could cause serious detriment to human health (Dockery et al.,1993).Status of air borne metals in air environment of urban centres in India have reported that RSPM concentrations in air is found to be exceeding the WHO guidelines (NEERI Report 2001). Status of airborne metals in India and various strategic approaches for management of air pollution have been reported (Gajghate and Hasan, 1995, 1996, 1999). Amongst the important urban centres like Delhi, Mumbai, Kolkata ; Ahmedabad is receiving great attention because of rising pollution levels. Ahmedabad city in Gujatat State of India has an area of 8707 sq. km. with a population of 58,08,378 (Indian Census 2003). Industrial structure in this state has been gradually diversifying with the development of industries like chemicals, petrochemicals, fertilizers, engineering, electronics etc. The number of vehicles in Ahmedabad were 45,000 in 1970 –71, which increase to 4 lacs in 1991 and presently city has more than 13 lacs vehicles plying on road. Ahmedabad is the fourth most polluted city in the country after Delhi, Mumbai, Kolkata and according to Central Pollution Control Board (CPCB), Ahmedabad ranked fourth in the country in deaths related to respiratory diseases. Gujarat Pollution Control Board (GPCB) believes that one of the major factors behind increasing pollution is vehicular pollution. RSPM is one of the greatest concern as it contributes about 50% of total urban air pollution load and also causes respiratory disorders in human beings. The Ahmedabad city's total pollution load is 316.58 tonnes a day which is next only to that of Delhi and Mumbai and much higher than that of other urban cities. Two and Four wheelers contribute about 74% of total emission load in city. The major cause of pollution are 42,000 old autorickshaws plying on city roads contributing major share to pollution load with 67% of them exceeding the pollution emission limit and the situation becoming worse with a reported 42% of Public Transport System in Ahmedabad city is only about 40 as against of about 80

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% in Metro Cities of India. This may be one of the reason in growth in number of private vehicles in the city. The main processes by which vehicle emit pollutants in environment are combustion processes and the poor maintenance, wear and tear of cars (India Green file, 2003). Hence, the present study reports for data / findings on the air quality of city in terms of concentrations of RSPM and toxic metals released during the year 2001. The paper highlights the status of RSPM and toxic metals along with contribution of metals with RSPM and also deals with variance analysis to find out sources of metals from various activities in the Ahmedabad city.

MATERIALS AND METHODS

The three sites representing Industrial, Commercial, and Residential areas were selected to cover entire city to study ambient RSPM and metal concentration in city's air. RSPM samples were collected from the sampling locations by operating Respirable Dust Samplers at an average flow rate of 1.5 m^3/min for 24 hrs. on pre-weighed glass fibre filter paper of 20 x 25 cm. size and reweighed after sampling in order to determine the mass concentration of the particles collected. The concentration of particulate matter in ambient air were then computed on the net mass collected divided by the volume of air sampled. Twelve circles of 2.8 cm. diameter were punched out from the filter paper and digested by microwave digestion system. The content was filtered through Whatman paper no. 42 and final volume was made upto 100ml by double distilled water. The filtrate was used to determine the metals including Cr, Cd, Fe, Zn, Pb, Ni by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES). The details of sampling procedures are given elsewhere (Katz, 1977; Markert, 1994).

RESULTS AND DISCUSSION

RSPM monitoring was carried out at Industrial, Commercial and Residential sites during the study period in Ahmedabad city. The study revealed that monthly average of RSPM level ranged from 94 to 648 ug/m^3 at Industrial site, 108 to 576 ug/m^3 at Commercial site and 102 to 505 ug/m^3 at Residential site. The air quality monitoring study revealed that in Ahmedabad, RSPM concentration at all sites exceeded the CPCB standards. The RSPM values were high in the month of March at Industrial, Commercial and Residential sites and low values were observed in the month of September at all these sites. Average RSPM values were higher in Summer season as compared to Winter and Monsoon at all the three sites. The cause of human health damage depends on concentration, nature and composition of RSPM. The characterization of RSPM for toxic metals composition was therefore undertaken.

The status of monthly average RSPM concentrations in Ahmedabad city is depicted in Figure 1. The monthly average concentration of Pb, Ni, Cr, Cd, Fe and Zn are given in Figure 2a & b. Lead in the atmosphere derived principally from the combustion of petrol containing lead and from smelting operations. Mean concentration of Lead during 2001 ranged from 0.008 to 0.166 ug/m^3 at Industrial site, 0.008 to 0.163 ug/m^3at Commercial and 0.008 to 0.735 ug/m^3 at Residential site. Nickel in the atmosphere originates from the combustion of fossil fuels, smelting and crustal sources. Mean concentration of Nickel varied from 0.006 to

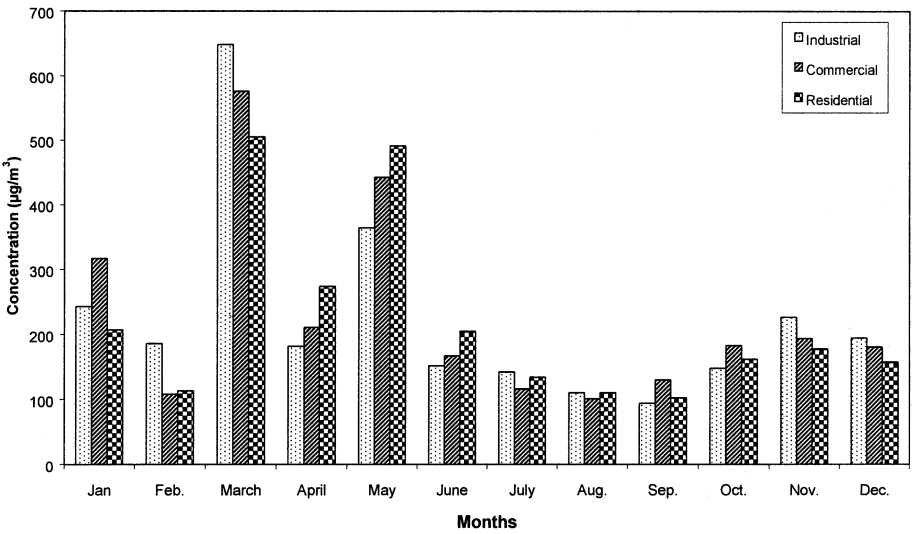

Figure 1. Status of monthly RSPM in Ahmedabad City : 2001

0.032 µg/m^3, 0.006 to 0.324 ug/m^{3}and 0.006 to 0.039 ug/m^3 at Industrial, Commercial and Residential respectively. Crustal sources, coal combustion and vegetation combustion contribute to Chromium in the air environment. Mean concentration of Cr varied from 0.001 to 0.010 ug/m^3, 0.001 to 0.015 ug/m^3 and 0.001 to 0.017 µg/m^3 at Industrial, Commercial and Residential respectively. Smelters, fuel combustion, paint and plastics manufacturing and are the prominent sources of Cadmium.

Mean concentration of Cd varies from 0.002 to 0.012 ug/m^3, 0.002 to 0.018 ug/m^3 and 0.002 to 0.007 ug/m^3 at Industrial, Commercial and Residential sites respectively. The mean concentration of Zinc varied from 0.001 to 3.723 ug/m^3, 0.001 to 3.526 ug/m^3 and 0.001 to 3.664 µg/m^3 at all Industrial, Commercial and Residential respectively. Zinc originates from coal combustion smelting operations, incineration and wood combustion. Mean concentration of Iron (Fe) varied from 0.164 to 1.373µg/m^3, 0.085 to 1.166µg/m^3 and 0.201 to 1.264 µg/m^3 at Industrial, Commercial and Residential respectively.

The presence of various toxic metals in ambient RSPM at three sites was studied. The annual percent contribution of toxic elements in RSPM is presented in Figure 3. It shows that Cd, Fe and Cr associated with RSPM of Industrial site are higher than RSPM of Commercial and Residential sites. However, Zn and Ni are more in Commercial site. The contribution of lead is significant in residential site which indicate the impact of vehicular traffic and other domestic sources prevailing in the proximity of study area. The analysis of variance (ANOVA) was carried out to test the null hypothesis of no significant difference between the means of the three sites. The calculated statistic with corresponding significance level is given in Table 1. It can be observed that for all the six metals there is no significant difference between the sites. It indicates that sources of all the metals at three sites are more or less same. In the present study it has been observed that vehicular pollution is a major culprit in deteriorating the air quality and health of people in

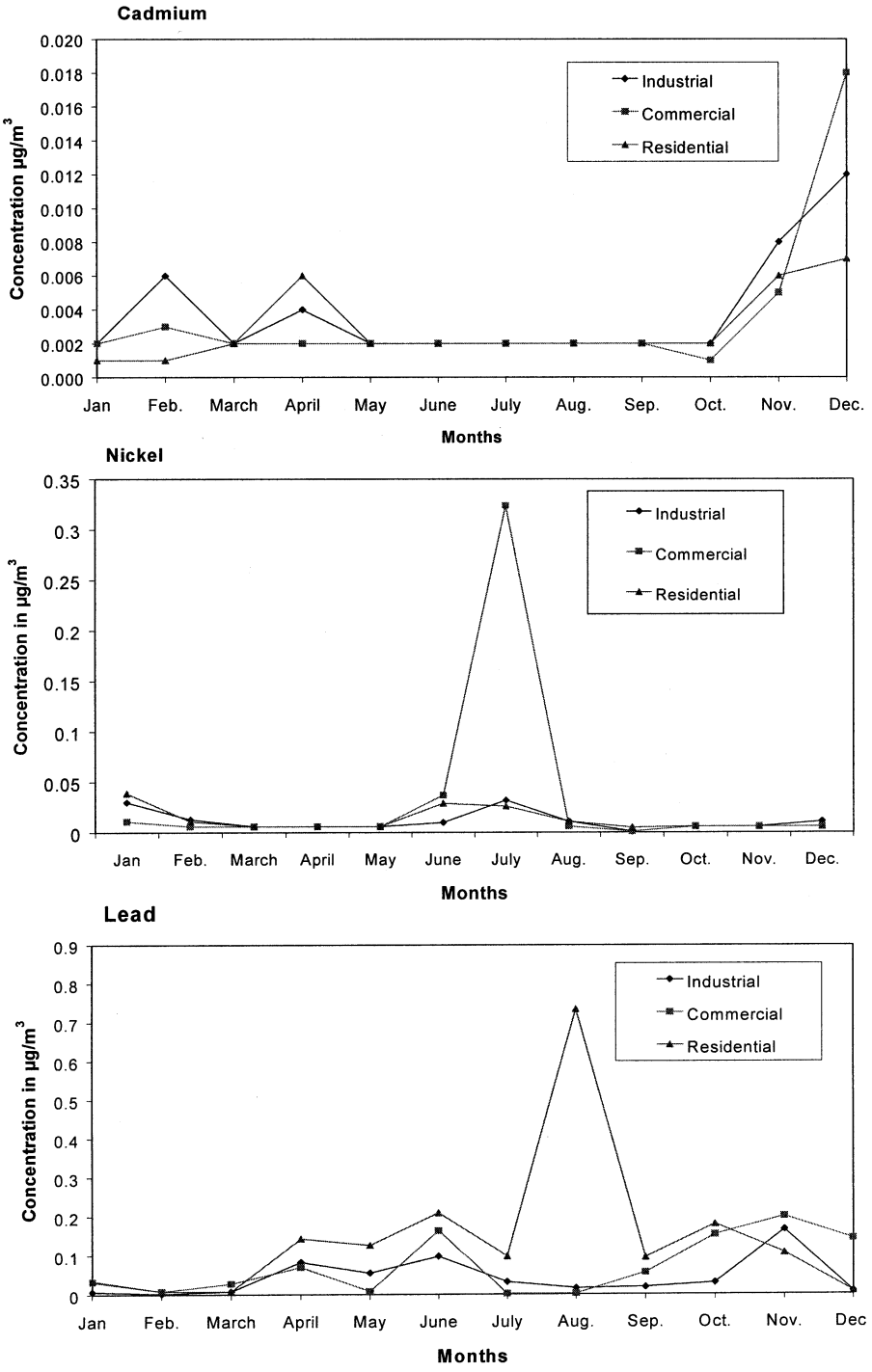

Figure 2a. Status of toxic elements in City of Ahmedabad : 2001

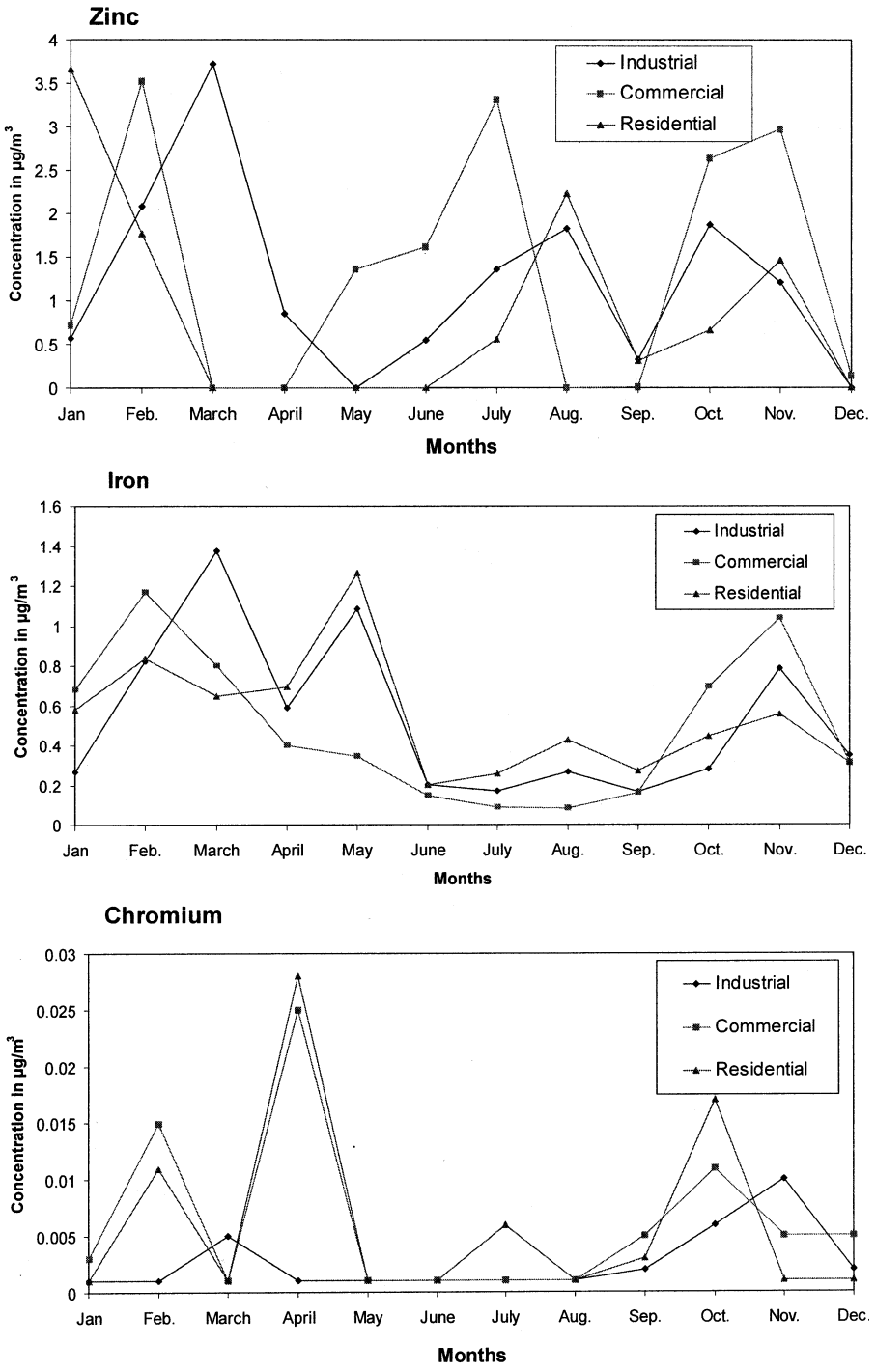

Figure 2b. Status of toxic elements in City of Ahmedabad : 2001

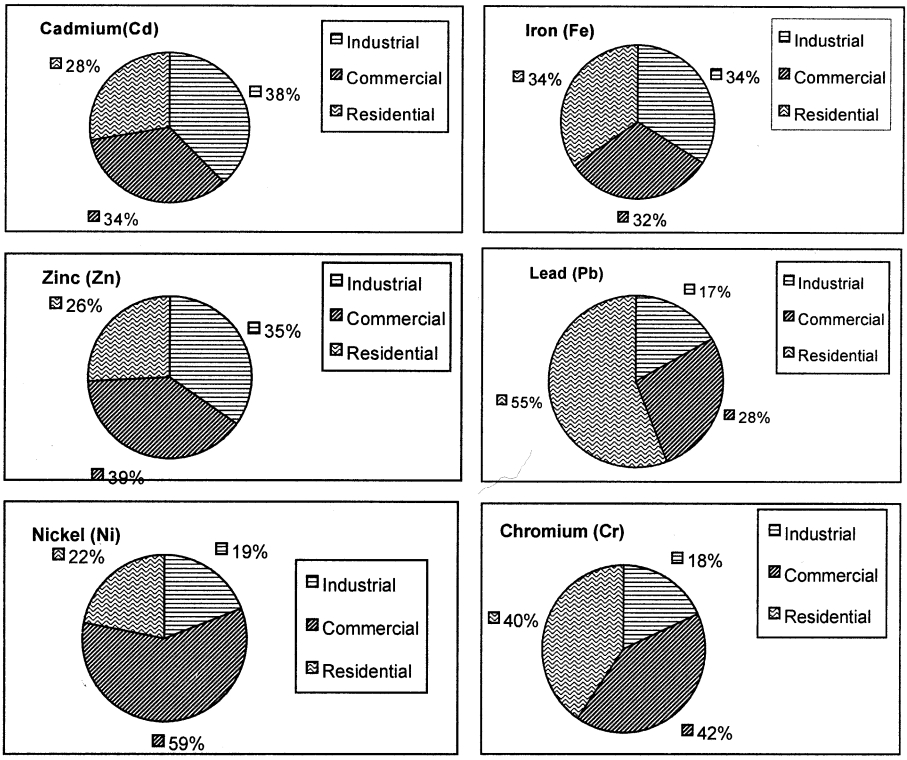

Figure 3. Annual percentage contribution of toxic elements in RSPM

Table 1. Analysis of variance for toxic elements.

	F (Statistic)	p value
Fe	0.058	0.943
Cd	0.221	0.802
Zn	0.453	0.639
Ni	0.317	0.730
Pb	2.152	0.132
Cr	1.023	0.370

city of Ahmedabad.

Certain control measures can be undertaken to abate air pollution viz., introduction of improved test procedures like transient loaded test and stringent emission standards for diesel commercial vehicles, private vehicles should be tested regularly to comply with emission standards and certified, use of alternative fuels like CNG in public transport systems. Preparing and implementing an effective urban air pollution control strategy requires educating society at all levels including policymakers, implementing agencies, manufacturing and service industries as well as the General public.

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