THE INVESTIGATION OF Cd, Cu AND Pb CONCENTRATIONS OF PARTICULATE MATTER IN URBAN, URBAN KERBSIDE AND INDUSTRIAL ATMOSPHERE IN ISTANBUL

Burcu Onat, Ulku Sahin, Cuma Bayat

Istanbul Üniversity, Engineering Faculty, Environmental Engineering Department, 34320, Avcilar/ISTANBUL-Turkey.
burcuonat@yahoo.com

Abstract: In this paper, the metal contents of atmospheric PM10 coming from urban, industrial and urban kerbside sites in Istanbul are investigated. PM 10 samples were collected at 10 stations which are located European and Asian side of the city. Dust samples collected on Glass fiber filters were digested and selected metals (Pb, Cu, Cd) were analyzed using by AAS (Atomic Absorption Spectrometry). The metal levels ranged from 0.005 $\mu g/m^3$ for Cd and 2.920 $\mu g/m^3$ for Pb. On the whole, the order of increasing metal concentration in urban, industrial and urban kerbside followed the order respectively: Cd<Pb<Cu, Cd<Cu<Pb and Cd<Pb<Cu.

Keywords: Air pollution, Particulate matter, trace metals.

INTRODUCTION

Air pollution has become a serious environmental issue, mainly due to the presence at toxic trace metals in the atmosphere as a consequence of rapid industrialization and increased transportation during recent years (Shah et al., 2005). Trace metals are found in almost all atmospheric aerosol size fractions (Samara and Voutsa, 2005). Recent epidemiological studies have revealed a strong link between elevated ambient concentrations of fine particulate matter (PM) and increased mortality and morbidity (Dockery and Pope, 1994). Metal associated with respirable particles have also been shown to increase lung or cardiopulmonary injuries caused by particulate air pollutant exposure (Costa and Dreher, 1997).

PM10 (aerosol size smaller than 10 µm) fraction of atmospheric aerosol has been very significant parameter in the last two decades. It contains hazard substances

F- 3

such as metals and carcinogen organic compounds causing diseases, even resulting in fatality. The studies have showed that the increase of 50 $\mu g/m^3$ of PM10 has caused an increase of % 1,4 ~ 3 on mortality (Schwarts et al, 1996; Dominici et al, 2002; Simpson and Miles, 1990; Ehrman et al, 1992; Ebelt et al, 2000).

Recently, a few studies related to particulate matter have been conducted in Istanbul. During the 1985-1991 heating season, particulate matter concentrations have exceeded the short term air quality standarts in many days (Tayanç, 2000). PM10 monitoring have been carried on since 1996 by Istanbul Municipality, Environmental Protection Directorate in Istanbul. Karaca et al. (2005) has monitored PM10 at non-impacted suburban site of Istanbul and explained the relationships between PM2.5, PM2.5-10 and PM10 data and determined the frequency distribution characteristics of PM2.5 and PM10.

The main goal of the present study was to investigate the heavy metal (Pb, Cd, Cu) concentrations of atmospheric PM10 in Istanbul. PM 10 samples were collected at 10 stations that have different characteristic (traffic load, industrial area or residental area) and analyzed with AAS (Atomic Absorption Spectrometry) and the results were explained considering the location of stations in the city.

2. Material and Method

2.1. Location of Stations

The ambient air quality is monitored by Istanbul Municipality, Environmental Protection Directorate in the 10 stations, placed at different points of Istanbul. The stations are located in the European side and Asian side of the city (Fig.1) and represents different ambient air quality (Table 1).
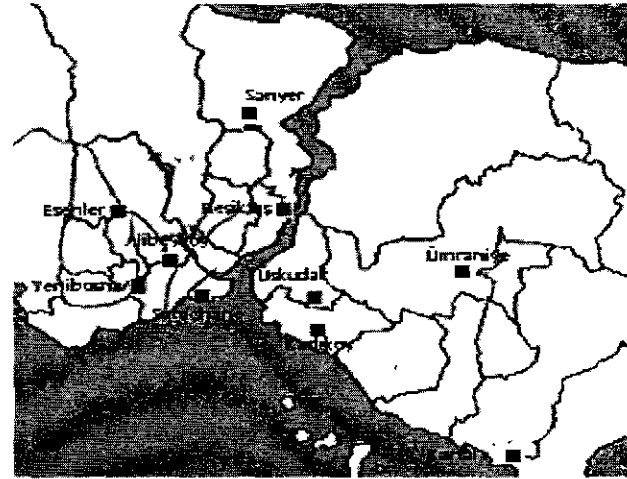

Figure 1: Map of Istanbul with the station locations

Table 1. The site characterization and sampling date

Site	Site Characterization	Number of Sample	Date of Samples
Yenibosna	Industrial	2	30 03/ 04.05. 2004
Esenler	Urban	3	23.02 / 31.03 / 04 05.2004
Sarachane	Urban kerbside	2	22 02 / 04.05.2004
Alibeykoy	Urban	3	22.02 / 30.03 / 03.05.2004
Besiktas	Urban kerbside	3	23.02 / 31.03 / 03.05.2004
Sanyer	Urban background	3	23.02 / 31.03 / 04.05.2004
Uskudar	Urban	3	22 02 / 30.03 / 03.05.2004
Umraniye	Industrial	2	22.02 / 01.04.2004
Kartal	Industrial	3	23.02 / 30.03 / 04.05.2004
Kadikoy	Urban	3	22.02 / 30 03 / 04.05.2004

2.2. Meteorology

The experimental study was demonstrated at 22-23 February, 30-31 March, 3-4 May 2004. During these time periods, the average temperatures were 3,7°C, 8,3 °C and 14,7 °C, respectively and the relative humidity were 70 %, 63 % and 68 % respectively in Istanbul. Sahin et al. (2005) reported that the correlation coefficients for PM_{10} and meteorological factors, the dominant meteorological parameters are found as wind speed and wind direction. According to the meteorological data in Istanbul, the daily dominant wind direction during the study period was between North-East and North-West and the maximum wind speed was 4,7 m/s, the minimum was 1,5 m/s. Rainfall was not recorded in the study period.

2.2. Sample Collection

Dust samples were collected at stations belonging to Istanbul Municipality, Environmental Protection Directorate. Site characterization, number of samples for each station and sampling times are given in Table-1. PM10 monitoring and dust samples collection were accomplished by Beta GAUGE Monitor (MP-101 M model, produces by Environment S.A., 1 m^3h^{-1} flow rate). Dust samples were filtered during 24 hours on 18,5 mm glass fiber filter during 24 hours. The filters were re-conditioned (24 hours in air conditioned room at 25 °C and 30 % RH) and then extracted in glass beakers by adding 15 ml HCl (35 %) and 5 ml HNO_3 (65 %) and subsequent heating apparatus (20 min. at 150 °C). Samples were cooled, filtered and digest was then filled up to 25 ml and analyzed with AAS (Unicam 929). AAS blanks were prepared simultaneously for a routine check for estimation of each metal in HCl, HNO_3 and blank filters. All measurements were calibrated by analysis of standard solutions containing known amount of the trace elements.

Table 2: Metal analyses and PM10 monitoring results for the Stations.

| | Sampl | Station Location | | | | | | | | | |
		Kadikoy	Umraniye	Kartal	Uskudar	Besiktas	Esenler	Sariyer	Alibeykoy	Yenibosn	Sarachane
PM10 (µg/m³)	No 1	74	-	68	48	48	104	84	68	-	49
	No.2	37	-	45	57	20	45	20	33	55	-
	No 3	43	-	74	40	56	49	49	24	67	75
Pb (µg/m³)	No 1	0 138	2 920	1.104	0.255	0 797	0.635	0.284	0 811	-	0 635
	No.2	0 488	0 462	0.515	2.279	0.815	0.554	1.863	0.698	0.566	-
	No.3	0.461	-	1.537	2.436	0.521	0 698	0.521	0.521	0 521	0.521
Cd (µg/m³)	No.1	0.065	0.107	0.020	0 060	0.089	0.082	0 089	0 029	-	0.278
	No 2	0.145	0.324	0.138	0 181	0 189	0.259	0 435	0 131	0 152	-
	No.3	-	-	-	-	-	-	-	-	-	-
Cu (µg/m³)	No.1	0.023	1.550	1.121	0.364	0.017	0.027	0.011	0.651	-	1.003
	No.2	2 202	0 065	0.081	0.072	0 082	0.064	0.648	0.890	0.281	-
	No 3	0.615	-	0.329	0.171	2.455	0 430	4 066	2.283	0.371	0 635

-. Because of technical problem (electric off, reparation etc.) in stations, filters have not been taken.

3. Results and Discussion

Table 2 summarizes the results of the metal analyses for all stations. The daily mean total concentration range of PM10 at Asian side of the city was 37-74 µg/m³. Kadıköy station is located in Asian side of Istanbul. This region has a great

population with dense residential areas, traffic load and commercial buildings. Heavy metals analyzed were variable, Pb was 0.138-0.488 µg/m³, Cd was 0.065-0.145 µg/m³ and Cu was 0.023-2.20 µg/m³. Ümraniye station is placed in suburban of Istanbul at Asian side. Air quality has affected from medium density of residential area and various industrial areas here. According to the metal analyze results, Pb was remarkably high level for sample 1; 2.920 µg/m³. Industries can be caused for high Pb result. Other metals were varying in periods; Cd was 0.107-0.324 µg/m³ and Cu was 0.065-1.550 µg/m³. Kartal station is located Asian side of the city and has an air pollution coming from industries, airport and traffic. Metal results were Pb; 0.515-1.537 µg/m³, Cd; 0.02-0.138 µg/m³ and Cu; 0.081-1.121 µg/m³. Uskudar station is placed at urban area of Istanbul near seaside. Air pollution is coming from traffic load and residential areas.

Beșikta☐ Esenler, Sarıyer, Alibeyköy, Saraçhane and Yenibosna stations are placed at European side of the city. The daily mean total concentration range of PM10 was 20-104 µg/m³.The air quality in Esenler and Alibeyköy stations located at urban area, is affected dense population and small industries. Heavy metals results were variable; Pb was 0.521-0.811 µg/m³, Cd was 0.029-0.259 µg/m³ and Cu was 0.027-2.283 µg/m³. Saraçhane and Besikta☐stations are placed next to the road in the city center. The order of metal concentration for two stations followed the order: Cd<Pb<Cu. And the results for Pb are very similar (changing between 0.521-0.815 µg/m³). Yenibosna station is in the middle of airport, highways and industrial sites. Metal results were Pb; 0.521-0.566 µg/m³, Cd; 0.041-0.152 µg/m³ and Cu; 0.075-0.281 µg/m³. Sarıyer station is located between Bosphorus and Black Sea. The air pollution originating Black Sea and residential areas is affected this area. According to the results, Pb; 0.523-1.863 µg/m³, Cd was 0.122-0.435 µg/m³ and Cu was 0.182-0.648 µg/m³.

4. Conclusion

The urban atmosphere of Istanbul (represented by Kadıköy, Uskudar, Esenler, Alibeyköy stations) is affected from dense residential areas, increasing traffic load and uncontrolled civilization. The dominant metal concentration is Cu changing between 0.023-2.283 µg/m³. The order of metal concentration in urban is Cd<Pb<Cu. The urban kerbside atmosphere (represented by Beșikta☐and Saraçhane stations) is under a pollution threat from vehicular emission. Increasing metal concentrations are in order Cd<Pb<Cu with metal levels for Cu: maximum and minimum concentrations are 2.455 µg/m³ and 0.017 µg/m³, respectively. The industrial atmosphere of Istanbul (represented by Yenibosna, Ümraniye and Kartal stations) is effected various industries. The dominant metal concentration is Pb with maximum level 2.92 and minimum level 0.515 µg/m³. The order of metal concentration in industrial sites of Istanbul is Cd<Cu<Pb. In the literature, Pb concentration of TSP urban area of Pakistan was determined as 0.003 – 4 µg/m³ (Shah et al., 2005). In the another study conducted by Heuglin in 2005, Cu and Pb concentrations in PM10 at urban kerbside of Bern-Switzwerland were observed between 0.017-0.074 µg/m³ and 0.020-0.049 µg/m³, respectively. Metal concentrations in particulate matter have variable values related to the area characteristics. Particularly, in metropolitan cities the population is greater than 10 million with high industrial facilities and highways such as Istanbul, it can be observed high metal concentrations in atmospheric particulate matter.

References

1. Costa, X., Dreher, X., 1997. Bioavailable transition metals in particulate matter mediate cardiopulmonary injury in health and compromised animal models. Environment and Health Perspectives 105 (5 suppl.), 1053-1060.

2. Dockery, DW, Pope, C.A., 1994. Acute respiratory effects of particulate air pollution. Annual Reviews of Public Health 15, 107-132.

3. Dominici, F., Daniels,M., Zeger, S.L., Samet, J.M. 2002. Air Polltion and mortality estimating regional and national dose-response relationships. J.Am. Stat. Assoc. 97:100-111.

4. Ebelt, S., Petkau, J., Vedal,S., Fisher, T., Brauer, M. 2000. Exposure of Chronic Obstructive Pulmonary disease Patients to Particulate Matter: Relationships

between Personal and Ambient air concentrations. Air &Waste Manage. Assoc. 50:1081-1094.

5. Ehrman, S., Pratsinis, S. 1992. Receptor Modeling of the Fine Aerosol at a Residental Los Angeles Site. Atmospheric Environment. Vol 26-4, 473-481.

6. Hueglin, C., Gehrig, R., Baltensperger, U. et. Al. 2005. Chemical characterization of PM2.5, PM10 and coarse particles at urban, ear-city and rural sites in Switzerland. Atmosp. Environment, 39 (4), 637-651.

7. Karaca, F., Alagha, O., Ertürk, F. 2005. Statistical characterization of atmospheric PM10 and PM2.5 concentrations at a non-impacted suburban site of Istanbul, Turkey. Chemosphere, 59, 1183-1190.

8. Sahin, U. Soyhan, B., BAYAT, C. 2005. Evaluation of PM2.5 and PM10 Distribution in Urban Area of Istanbul as a Function of Meteorological Parameters, 3rd International Conference on Ecology Protection of The Planet Earth Sempozium, Istanbul.

9. Samara, C., Voutsa, D., 2005. Size distribution of airborne particulate matter and associated heavy metals in the roadside environment chemosphere 59, 1197-1206.

10. Simpson, R.W., Miles, G. 1990. Controlling Emissions to Avoid Violations of Health Standards for Short Term and Long Term Exposures to TSP Concentrations. Atmospheric Environment. Vol 24-1, 99-105.

11. Shah, M.H., Shaheen, N., Jaffar, M., Khalique, A., Tariq, S.R., Manzoor, S., 2005. Soatial variations in selected metal contents and particle size distribution in an urban and rural atmosphere of Islamabad, Pakistan. Journal of Environmental Management. Article in Press (1-10)

12. Tayanç, M., 2000. An assessment of spatial and temporal variation of sulfur dioxide levels over Istanbul, Turkey. Environmental Pollution 107, 61-69.