Metal Concentrations in atmospheric particulate from seoul and asan, in Korea

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Abstract

Daily average concentrations of fine particulates have been measured simultaneously in Seoul and Asan area by using PM minivolTM portable air sampler(Air Metrics, U.S.A) from September 2001 to August 2002.
The sampler were analyzed by ICP-OES(inductively coupled plasma optical emission spectrometry, optima 3000DV, Perkin Elmor) to determine the fine particulate concentrations of metallic elements(As, Mn. Ni, Fe, Cr, Cu, Cd, Pb, Zn, Si).
The concentration of $PM_{2.5}$ showed a high trend in the Seoul area.
Zn showed a similar distribution ratio for the fine particle in both Seoul and Asan.
Mn and Fe, Cr, Cd are highly correlated in the Seoul and Asan area($P<0.05$).
Author keywords : fine particulate, metal analysis, $PM_{2.5}$

Introduction

Atmospheric aerosol particles play an important role in our everyday life and in the control of different processes in the air.[1] It is well recognized that environmental effects of aerosol particles depend on their size and chemical composition. Thus, solar radiation transfers in the air, cloud-aerosol interactions and biosphere impacts are all determined by the size distribution of particles of different composition.[2] Particulate matter with a 50% cut-off diameter of 10㎛ (PM_{10}) has been associated epidemiological studies with increased mortality, increased morbidity, decreased lung function.[3] Industrial processes such as metal refining and fossil fuel combustion have lead to a substantial increase of trace elements in the atmosphere.[4] Heavy metals such as Pb, Cu, and Zn are diffused into the atmosphere by heavy industry, coal burning, metallurgical smelters and automobile traffic.[5]

To understand the particulate and metal element concentration after long distances transportation from urban area. The study is intend to characterize fine($PM_{2.5}$) and the metal element particulate size fraction in Seoul and Asan during one year.

Materials and Methods

- Sampling Site -

Samplers of atmospheric aerosol were collected from September 2001 to August 2002 at a school of natural science, Soonchunhyang University, Asan, and also collected at tha school of medical science, Hanyang University, Seoul.

Daily $PM_{2.5}$ samples were collected on pall flex membrane filter(47mm, Gelman science) with minivol portable air sampler.

The membrane filters were previously dried in a desiccator for a 48hour-period and weighed to a precision of 0.01mg in an analytical balance.

After collection, the used filters were placed in the desiccator dried for another 48hour-period, and weighed again in the same analytical balance(Sartorius, BP211D, Japan).

- Chemical Analysis(Metal Elements Concentration) -

To Extract metal elements from fine particles, we used microwave(Questron Co, Qlab 6000)pretreatment method, which was recommended by US EPA(1999).

As shown Figure 1, sample filter placed in microwave vessel and was added 10mℓ of mixture 1.03 M HNO_3 and 2.23M HCl, then was heated the microwave oven with 545Watt for 10min and 344watt for 5min.

The microwave pretreatment method can be shortened time and analyzed at high temperature and high pressure. We analyzed ten metal element concentrations such as As, Ni, Fe, Cr, Cd, Cu, Pb, Zn and Si by ICP-OES(inductivity coupled plasma optical emission spectrometry, Optima 3000DV, Perkin-Elmer Co.). Metal elements concentration was adjusted with blank value that obtained by the same method as described above.

We analyzed Mass and metal concentration data by SPSS 11.0 & Excel 2000 program. This measurements paired data were correlated and Mann-whitney U test was used to compare means for each city.

Filter into microwave vessel

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Adding HNO3(1.03M)+HCl(2.23M) 10ml in the vessel

↓

Heating the microwave oven with 545W for 10min, 344W for 5min

↓

Cooling the vessel

Figure 1. Pretreatment of samples using microwave

Result

Table 1 indicated that average mass concentrations of fine particles in Asan and Seoul were 37.70 ㎍/㎥ and 5.83 ㎍/㎥. When the weather conditions were classified as normal and yellow sand, measured average mass concentrations of fine particles in yellow-sand weather condition was significantly higher than those of normal weather condition in both cities($P<0.05$).

Table 1. Concentrations (㎍/㎥) of fine particles (PM2.5) in normal weather and yellow sand conditions in Asan and Seoul

	Asan		Seoul		
	n	Mean±S.D. (Range)	n	Mean±S.D. (Range)	
Yellow sand condition	7	58.33±22.99 (33.10~89.81)	7	(59.03±203.01)	
Normal weather condition	44	(13.43 ~ 99.07)	24	(2.78 ~ 87.50)	
Total	51	37.70±18.41	31	45.83±38.50	0.785
p^b		0.009**		0.000**	

p^a(p-value) : Mann-Whitney U test between concentrations of particles of Asan and Seoul
p^b(p-value) : Mann-Whitney U test between concentrations of particles of yellow sand condition and normal weather condition

Table 2 showed that average mass concentrations in spring were mostly higher than in another seasons in both cities

Table 2. Seasonal concentrations (㎍/㎥) of fine particles ($PM_{2.5}$) in Asan and Seoul

	Asan		Seoul(p^a)		
	n	Mean±S.D. (Range)	n	Mean±S.D. (Range)	
Spring	13	47.76±19.07 (20.14 ~ 89.81)	5	61.53±4.37 (58.10 ~ 68.75)	0.026*
Summer	12	29.44±9.85 (13.43~46.06)	2	25.42±8.10 (19.69~31.15)	0.584
Fall	13	39.19±24.57 (14.12~99.07)	12	45.60±53.30 (13.89~203.01)	0.430
Winter	13	33.78±12.62 (18.98~71.30)	12	42.92±31.49 (2.78~126.16)	0.231
p^b		0.017*		0.082	

p^a(p-value) : Mann-Whitney U test between concentrations of particles of Asan and Seoul
p^b(p-value) : Kruskal-Wallis H test between concentrations of particles with regard to season

Table 3 indicated the average metal elements composition in the fine particle mode during the sampling time. Average concentrations of Mn, Fe, Cr, Cd, Pb, in Asan were a little higher compare with each average in Seoul.

Zn showed a similar distribution ratio for the fine particleint both Seoul and Asan area(Table 4). Table 5 indicated that Mn and Fe, Cr, Cd, are highly correlated both Seoul and Asan area($P<0.05$).

The results of this study implied that the proper management for fine particles was required in the medium(Asan)city. The concentrations of metallic elements in fine particles in Asan were relatively higher than those in Seoul.

Table 3. Concentrations (ng/㎥) of metallic elements in fine particles (PM2.5) in Asan and Seoul

	Total			pa	pb
	Asan	Seoul			
	Mean ±S.D.		p		
As	7.11±8.22	8.69±9.00	0.552	0.259	0.962
Mn	19.47±16.16	10.45±14.05	0.000**	0.012*	0.002**
Ni	8.96±12.37	N.D.	N.A.	0.070	N.A.
Fe	313.14±389.04	219.62±546.86	0.000**	0.001**	0.001**
Cr	7.64±9.74	1.29±1.46	0.000**	0.681	0.088
Cu	109.15±65.59	93.67±58.35	0.331	0.112	0.479
Cd	2.08±1.90	1.27±1.67	0.023*	0.125	0.313
Pb	45.24±44.20	25.59±29.38	0.027*	0.180	0.217
Zn	107.26±50.81	106.72±68.25	0.837	0.603	0.450
Si	574.69±924.60	274.83±1289.69	0.000**	0.000**	0.022*

p^a : Mann-Whitney U test between concentrations of metallic elements in particle in yellow sand and normal weather condition of Asan

p^b : Mann-Whitney U test between concentrations of metallic elements in particles in yellow sand and normal weather condition of Seoul

N.D. : Not Detectable

N.A. : Not Applicable

Table 4. Correlation matrix among metallic elements in Asan

	As	Mn	Ni	Fe	Cr	Cu	Cd	Pb	Zn
Mn	-0.301**								
Ni	-0.127	0.505**							
Fe	-0.273	0.594**	0.038						
Cr	-0.217	0.392**	0.581**	0.088					
Cu	-0.147	0.277*	0.681**	0.087	0.752**				
Cd	-0.002	0.533**	0.538**	0.328*	0.342*	0.424**			
Pb	0.168	0.135	0.217	-.084	0.196	0.283*	0.540**		
Zn	-0.1660	0.263	0.488**	0.064	0.655**	0.866**	0.469**	0.361**	
Si	-0.181	0.505**	-0.143	0.905**	-0.079	-0.133	0.297*	0.029	-0.052

* $p<0.05$ **$p<0.01$

Table 5. Correlation matrix among metallic elements in Seoul

	As	Mn	Fe	Cr	Cu	Cd	Pb	Zn
Mn	-0.224							
Fe	-0.154	0.941**						
Cr	-0.002	0.602**	0.628**					
Cu	-0.256	0.288	0.064	0.086				
Cd	-0.441**	0.826**	0.712**	0.453**	0.586**			
Pb	-0.250**	0.457**	0.161	0.111	0.780**	0.634**		
Zn	-0.286	0.298	0.082.	0.077	0.993**	0.614**	0.772**	
Si	-0.146	0.882**	0.982**	0.590**	0.043	0.675**	0.070	0.067

* $p<0.05$, ** $p<0.01$

References

1) Preining, O. ; The many facets of aerosol science. J aerosol Sci. 27.pp. S1-S6. 1996.
2) Meszaros, E, Barcza, T. ; size distributions of inorganiz and organiz species in the atmospheric aerosol in Hungary. J .Aerosol Sci. 28.pp 1163-1175. 1997.
3) Saskia, C, Harrssema, H. ; Characterization of particulate air pollution in urban and non-urban area in the Netherlands. Atmos. Environ. 32.pp.3717-3729. 1998.
4) WHO ; Air Quality Guidence for Europe. 1987.
5) Pacyna, J.M. ; Atmospheric trace elements from natural and anthropogenic sources in : Toxic metals in the atmosphere. Wiley, New York. pp. 33-52.