IMPROVING AIR QUALITY IN HANOI, VIETNAM: STUDY OF FINE AND COARSE PARTICLES

Hoang Xuan Co[1], Dam Duy An[1] and Nghiem Trung Dung[2],

[1] Faculty of Environmental Sciences, Hanoi University of Science
334 Nguyen Trai Road, Thanh Xuan, Hanoi, Vietnam, Tel: 84 4 5583305, Fax: 84 4 8583601

[2] Institute for Environmental Science and Technology, Hanoi University of Technology
No. 1 Dai Co Viet , Hanoi, Vietnam

Abstract

Atmospheric particulate concentrations for total particulate matter (TSP), fine (particulate matter less than 2.5 micron) and coarse particles (particle with diameter 2.5-10 micron) were measured in 5 locations in Hanoi, at mixed, residential, commercial, traffic and background sites. Samples on each location were collected over one days-time (24h) periods during dry season using Dichotomous sampler, High and Low Volume Samplers. Meteorological conditions were also measured simultaneously in the sampling locations. Samples were further analysed to determine concentrations of particulate mass, elements, ions. The results from this study show that the concentrations of the particulate mass were different between the sites. The average fine particles concentration at mixed site was 77 μg/m3 for the dry season. The average coarse particles concentrations was 35 μg/m3 for dry season. The average mass concentration of fine particles at the residential site was 216 μg/m3 for dry season, while for the coarse particles the concentration was 22 μg/m3 for dry season. Fine particulate contribute about 69 % to the PM10 in mixed site and about 90% in residential site. This indicates that fine particles may come from other places (transported) in the residential area.

Keywords: total suspended particle (TSP), PM_{10} , PM2.5, nitrate, sulphate, calcium, lead, fine fraction, coarse fraction

Introduction

Particulate matter is one of common types of air pollutants. Although PM comprises a low percentage of the total mass of man-made air pollutants, the potential hazard from this type of pollutant is high. PM presents a health hazard to the lung, enhances chemical reactions in the atmosphere, reduces visibility and solar radiation with concomitant changes in environmental temperature and biological rates of plant growth and soil materials extensively. The magnitude of the problem in each of the above areas is a function of the range of particulate sizes in the local atmosphere, the particulate concentration and the chemical and physical composition of the particulate (Wark, 1981).

Particulate is a term employed to describe dispersed airborne solid and liquid particles larger than single molecules (approximately 10^{-10} m in diameter) but smaller than 500 μm. Particles in this size range have a lifetime in suspension varying from a few seconds to several months. Particles above approximately 20 μm have large settling velocities and are removed from the air by gravity and other inertial processes (Wark, 1981). Particulate matter can be measured in term of different types such as total suspended particulate (TSP), PM_{10} and $PM_{2.5}$ etc. TSP is generally considered to be particles of less than 15 μm suspended in the atmosphere (Harrison and Perry,1986).

Many toxic air pollutants including polycyclic aromatic hydrocarbons (PAHs), lead, cadmium, arsenic etc. are associated with PM. A number of EPA-selected PAHs including carcinogens was detected on PM emitted from a coal-fired power plant in Vietnam (Dung, 1996). A high level of PAHs and PM emissions from domestic combustion of selected fuels (from Vietnam and Thailand) was reported in a study conducted by Kim Oanh et al (1999). In another study, also conducted by Kim Oanh et al (2000) in Thailand, PAHs

on ambient PM were recorded. It was also indicated by Garivait (1999) that many toxic air pollutants including PAHs, cadmium, selenium, lead etc. are adsorbed on PM.

It is documented that PM can come from different sources. In Vietnam combustion of fossil fuels for energy purpose, construction and transportation are considered to be main contributors of PM emissions in big cities including Hanoi. Although the consumption of fossil fuels in Vietnam is not so high, about 5 - 8 million tons of coal and 3 - 5 million tons of oil per year, sources of combustion are highly centralised in big cities resulting in possible PM pollution (Anonymous I, 1996-1999 and Phong, 1998).

In the last few years, economic activities in Vietnam such as combustion of fossil fuel for energy purpose, construction and transportation etc. have been increasing very fast (Anonymous III, 1995). Consequently, like some developing counties, the development of the economy resulted in air pollution including PM, especially in big cities like Hanoi (Duong et al, 1993).

Hanoi has tropical climate with monsoon and cold winter. Hanoi is the capital of Vietnam. It is also one of the biggest cities with high population density. There are different industrial enterprises/factories in Hanoi. They are generally not well-equipped with air pollution control techniques. At present building activities in the city are high. A high number of motorcycles are used. Additionally, traffic vehicles are mainly backward. Hanoi may also be affected by industrial enterprises/factories 30-40 km surrounding such as Pha Lai coal-fired power plant.

According to Anonymous I (1996-2002) common air pollutants such as CO, NO_2, SO_2 in Hanoi are usually monitored. Sometimes, PM is also measured. However, data related to PM and toxic air pollutants associated with it are scare or not quantitative in the literature so far. This leads the necessity of monitoring of PM in the city and analysis of chemical characterisation of the PM to assess air quality as well as sources contribution on the toxic air pollutants associated with PM for future environmental protection. This research is therefore proposed to address these major issues in Hanoi:

Methods

1. Sampling for TSP, PM_{10} and $PM_{2.5}$ using Dichotomous sampler, High and Low Volume Samplers
2. Calibration of analytical equipments by SRM and inter-lab performance.
3. Analysis of toxic air pollutants associated with fine PM collected:

PM on samples collected at five sites was determined by gravimetric method.

PM_{10} and $PM_{2.5}$ collected at from five sites have been being analysed by XRF at the Institute of Nuclear Science and Technique, Vietnam Atomic Energy Commission. Around 10 elements were detected on each sample including Si, S, K, Ca, Ti, Mn, Fe, Sn, Cr, Pb and Al. Samples that had been analysed by XRF have been analysed by ICP/MS at the Institute for Technology of Radioactive and Rare Elements, Vietnam Atomic Energy Commission and/or by AAS and Polarograph at the Institute for Environmental Science and Technology (INEST), Hanoi University of Technology for additional elements.

Samples collected for PAHs and ions are being analysed following US EPA TO-13 method.

Results and Discussion

Data analysis and compilation

It can be seen from Table 1 that:

- Values of PM_{10} collected by different samplers at the same site can be considered to be in the same range.

- Major portions of TSP at the five sampling sites are PM10.
- The samples collected at the residential site have the highest percentage of fine PM (PM10 and PM2.5) in TSP. This point has a good agreement with Anonymous I, 2000.

Table 1. Average concentrations of PM at the five sites

Parameter	Sampler used	Average concentrations of PM at the sites, mg/Nm^3				
		Mixed	Background	Residential	Commercial	Traffic
PM2.5	Dichot	0.077	-	0.216	0.112	-
PM10	Dichot	0.112	-	0.238	0.133	-
	LVS	0.154	0.117	0.302	0.485	0.440
		-	-	-	-	0.328
	HVS	-	**0.165**	-	-	-
TSP	HVS	0.184	-	0.388	0.488	0.579
% PM10 in TSP, %		72.28	-	79.88	63.32	66.32
% PM2.5 in PM10, %		68.75	-	90.75	84.42	-

Figure showed the contribution of the Chlor, Nitrate, Sulphate to PM10 at mixed site. Figure 2 presented the contribution of metals to fine and coarse fraction at mixed site.

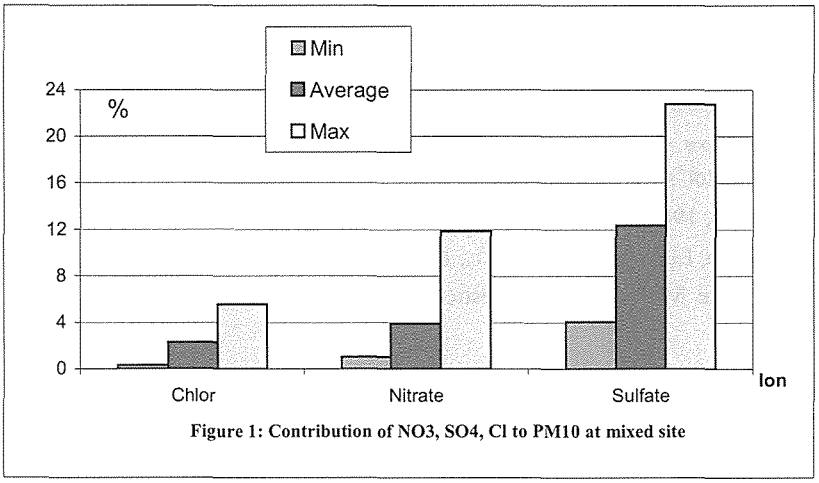

Figure 1: Contribution of NO3, SO4, Cl to PM10 at mixed site

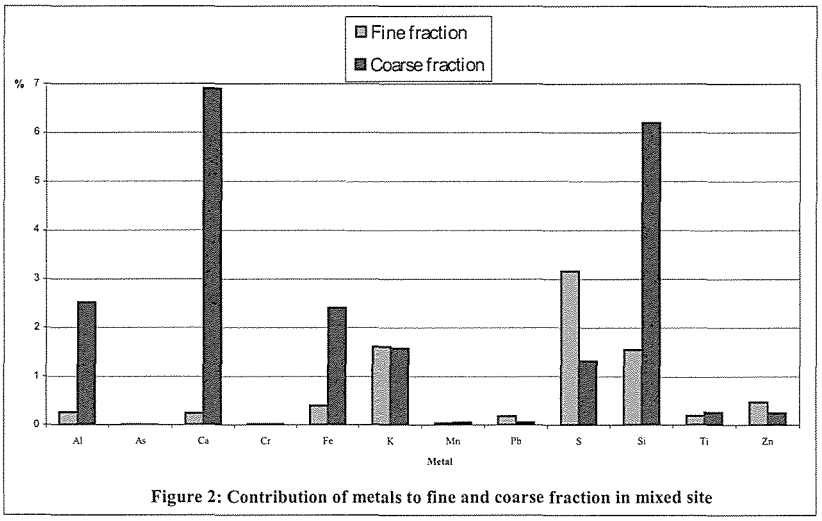

Figure 2: Contribution of metals to fine and coarse fraction in mixed site

Conclusion

In Hanoi, the air quality is in decreased trend. Especially, concentration of TSP, PM10 have exceeded the standard one in urban area with high population and traffic density.

Acknowledgement

This research project was funded by Swedish International Development Cooperation Agency (SIDA) through Asian Regional Research Program on Environmental Technology coordinated by Asian Institute of Technology (AIT)

References

Anonymous I., 1996-2001. *State of Environment of Vietnam, Reports*. Ministry of Science, Technology and Environment, Hanoi, Vietnam.

Anonymous II., 2000. Data of Petrolimex. Hanoi, Vietnam.

Anonymous III, 1995. *Survey and State Policy of Energy by the Year 2005*. The Ministry of Science, Technology and Environment, Hanoi, Vietnam (in Vietnamese).

Anonymous IV., 1988. *Compendium of methods for the Determination of Toxic Organic Compounds in Ambient Air*. US. EPA.

Dung, N.Tr., 1996. *Determination of Some Selected Polycyclic Aromatic Hydrocarbons on Particulate Emitted from the Thermal Power Plant of Bai Bang Paper Company*. AIT Master's Thesis No. EV-96-24.

Duong, D.H., Hien, D.X., and Luong, N.D., 1993. *Scientific Background of Environmental Monitoring System of Air and Water in Vietnam. In: Environmental Protection and Sustainable Development*. Hanoi, Vietnam.

Garivait, H., 1999. *A Study on Air Pollution by Airborne Polycyclic Aromatic Hydrocarbons (PAHs) in Bangkok Urban Atmosphere*. AIT Doctor's Dissertation No. EV-99-1

Harrison, R.M., and Perry, R., 1986. *Handbook of Air Pollutant Analysis*. Chapman and Hall Ltd., USA.

Kim Oanh, N.T., Reutergardh, L.B., and Dung, N.Tr., 1999. Emission of Polycyclic Aromatic

Hydrocarbons and Particulate Matter from Domestic Combustion of Selected Fuels. *Environmental Science and Technology*. 33: 2703-2709.