

Abstract

Airborne particulate matter is a potent air pollutant and causes detrimental impact on human health in an urban area. It also responsible to deteriorate the visibility in urban atmosphere, cause of the decay of material and interact into the phenomena of global climate change. Thus, I carried out several studies to dig out particularly the mass distributions in the extended ranges of size fractions, i.e., $PM_{2.5}$, $PM_{2.5-10}$, $PM_{>10}$, and SPM aerosol, chemical nature, and sources of elements which are considered to be afflicting concern of human health and environment. Particulate matter samples were collected from multiple sites consisting of two urban, one suburban and another residential in wide areas of Yokohama, Japan. $PM_{2.5}$, $PM_{2.5-10}$ and $PM_{>10}$, and SPM samples were captured with MCI and Shintaku low volume air samplers. Samples were then subjected to analysis for metals, water-soluble ions and carbonaceous mass using inductively coupled plasma method (ICPMS), ion chromatograph and CHN corder, respectively.

Comprehensive chemical characterization of elemental composition of suspended particulate matter (SPM) samples collected monthly from 1999 till 2005 at two locations (urban and suburban) in Yokohama, Japan was carried out. The results indicate that the composition of SPM on one of the sites is determined by automobile emissions and on the other by industrial combustions. The impact of the emission regulations for automobiles in large Japanese Cities, that were enacted during 2002 and 2003, on the SPM composition of the samples is also studied.

PCA-APCS technique was appropriately employed for source apportionment analysis of SPM samples collected at the above two locations (urban and suburban) in Yokohama, Japan. Major source factors (on interim basis) of SPM at site A were a) soil dust, b) road traffic, c) waste incineration, and d) mineral re-suspension. At site B, the sources (on interim basis) were predicted as a) road traffic, b) industry, c) soil dust, and d) secondarily formed aerosol. Road traffic and waste incineration were the most significant sources at site A. However, road traffic and secondarily formed aerosol were found to be predominant source at site B. The nature of the SPM sources at sites A and B were quite unique except for the road traffic. The tracers and nature of the traffic source at both sites were similar but retained different source strength.

A comparative source apportionment of SPM aerosol using US EPA PMF 3.0 and PCA-APCS was also performed to evaluate a procedure of handling data together in the above methods. A comparison was made with the results of PMF 3.0 and PCA-APCS. SPM aerosol samples collected from two sites were treated together in PMF apportionment procedure. Consequently, PCA-APCS accomplished source apportionment using the similar set of samples. The major findings obtained from the results of PMF 3.0 indicated that source fingerprints and contributions are pragmatic and expected. The most vibrant sources commonly resolved by both PMF 3.0 and PCA-APCS procedures showed a consistent and expected results with lower standard errors of mean. However, weaker sources presented somewhat flat results with larger error of mean and uncertainty. Thus, the procedures of data selection being tested in this investigation could be reasonable way of handling data produced from multiple sites at the close proximity within the study area.

Chemical characterization of $PM_{2.5}$, $PM_{2.5-10}$ and $PM_{>10}$ collected from an urban site for the period of 2007 – 2008 was studied. The total number of $PM_{2.5}$, $PM_{2.5-10}$ and $PM_{>10}$ samples collected with MCI sampler were 91, 87 and 79, respectively. The annual arithmetic mean concentrations of $PM_{2.5}$, $PM_{2.5-10}$ and $PM_{>10}$ were 20.6, 9.6 and 5.1 $\mu\text{g m}^{-3}$, respectively. The results of the daily $PM_{2.5}$ concentrations indicated that 67% of the daily $PM_{2.5}$ exceeded USEPA National Ambient Air Quality Standards (NAAQS) (15 $\mu\text{g m}^{-3}$) while 95% in respect of WHO ambient air quality guidelines (10 $\mu\text{g m}^{-3}$). The concentrations of water soluble ions in $PM_{2.5}$, $PM_{2.5-10}$ and $PM_{>10}$ accounted for 40%, 31% and 19%, respectively. The estimation of non-sea salts particles implies that the major sources of water soluble ions in $PM_{2.5}$ are anthropogenic. On the other hand, large proportion of sea salts particles contribute to $PM_{2.5-10}$ and $PM_{>10}$. The concentration of OC in summer months was high due to the formation of SOC in $PM_{2.5}$, $PM_{2.5-10}$ and $PM_{>10}$. The concentration of OC from primary sources dominantly contributed to the $PM_{2.5}$ than $PM_{2.5-10}$ and $PM_{>10}$. In addition, some atmospheric reactions were also characterized in this study.

Chemical characterization and discrimination of sources of $PM_{2.5}$, $PM_{2.5-10}$ and $PM_{>10}$ collected from a residential location in Yokohama, Japan, for the period of September, 2008 to July, 2009, were investigated employing PCA-APCS as a source apportionment tool. The results indicated that arithmetic mean concentrations of $PM_{2.5}$, $PM_{2.5-10}$ and $PM_{>10}$ were estimated as 23.9 ± 9.4 , 12.5 ± 8.9 and $7.7 \pm 5.2 \mu\text{g m}^{-3}$, respectively from 32 samples of each fractions. Annual mean concentration of $PM_{2.5}$ exceeded WHO air quality guideline value of 10

$\mu\text{g m}^{-3}$, US EPA National Ambient Air Quality Standard of $15 \mu\text{g m}^{-3}$ and the standards ($15 \mu\text{g m}^{-3}$) recently accepted by the Ministry of Environment, Japan. Seasonal variability of particles mass (i.e., $\text{PM}_{2.5}$, $\text{PM}_{2.5-10}$ and $\text{PM}_{>10}$) was not observed during the study period. However, the effect of East Asian dust was noticed in spring episode. Distributions of 20 metals in $\text{PM}_{2.5}$, $\text{PM}_{2.5-10}$ and $\text{PM}_{>10}$ were also studied. The results of metal distributions indicated that V, Ni, Cu, Zn, Ga, As, Se, Ag, Cd, Pb, and Bi in $\text{PM}_{2.5}$ should be most likely released from the anthropogenic settings actively operating around the study location. However, Mg, Al, Ca, Mn, Cr, Rb, Sr, Cs, and Ba might associate with $\text{PM}_{2.5}$ due to the agglomeration of naturally derived dust. Natural phenomena might more predominantly cause the emissions of metals in $\text{PM}_{2.5-10}$ and $\text{PM}_{>10}$. The most possible sources of $\text{PM}_{2.5}$, $\text{PM}_{2.5-10}$ and $\text{PM}_{>10}$ were illustrated in this article. The leading sources identified in $\text{PM}_{2.5}$ were made contributions in the following orders: automobile > industry I > soil dust > industry II. However, soil dust appeared as most striking contributor to $\text{PM}_{2.5-10}$ and $\text{PM}_{>10}$. The magnitude of predicted sources could be described in the following orders: soil dust > mineral re-suspension > combustion of coal as well as soil dust > road dust for $\text{PM}_{2.5-10}$ and $\text{PM}_{>10}$, respectively.