PA45) Characteristic of $PM_{2.5}$ Carbonaceous Species in an Urban Area of Ulsan

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1. Introduction

In recent years, pollution of particulate matter (PM) such as fine particles has become one of serious environmental problems in many countries (Almeida et al., 2005). $PM_{2.5}$ (particulates less than $<2.5\mu m$) has been implicated in adverse human health effects (Laden et al., 2000). In particular, $PM_{2.5}$ consists of mixture of many chemical species. Carbonaceous species, including organic carbon (OC) and elemental carbon (EC), are reported as major components of fine particles. For example, carbonaceous species in polluted atmosphere account for 20~50% of $PM_{2.5}$ mass (Park et al., 2001). Carbonaceous aerosols have significant effects on global and regional climates, and adverse effects on human health and local environment.

EC arises as the result of incomplete combustion of various kinds of organic material, including coal, oil, wood and other biomass. Primary OC has similar sources, but it also results from resuspension of traffic related dust and primary biogenic particles, fungal spores and all kinds of vegetational debris (Hildemann et al., 1994). Secondary OC results from atmospheric reactions of organic volatile and semi-volatile compounds with reactive trace gases (O_3, OH, NO_3, NO_2, etc) (Seinfeld and Pandis, 1998). OC is a matter of concern to human health, because some organic compounds (e.g. PAHs, PCBs, PCDFs) are potentially mutagenic and carcinogenic (Finlayson-Pitts and Pitts, 2000). Ulsan is the largest industrial city of Korea and there is a lack of OC and EC information in the air. The prompt of this study is to characterize $PM_{2.5}$ carbonaceous species in an urban residential area of an industrial city to assist in developing strategies for control of carbon pollution.

2. Methods

Air-borne $PM_{2.5}$ samples were collected from a typical residential area of Ulsan using $PM_{2.5}$ sampler (Model PQ200, BGI Inc., Waltham, MA, USA) operated at a constant flow rate of 16.7L/m. Quartz filters (Type QM/A ultrahigh-purity quartz filters, from What-man) with 47mm in diameter were pre-heated at 650°C for 8-h before sampling to remove residual carbon. The exposed filters to air were stored in a refrigerator at about 4°C before chemical analysis to prevent evaporation of volatile components. Air samplings based on 24-h were conducted during two seasons, winter and spring of 2009.

All the filters were stored for 24-h before weighing them in a controlled room at a temperature of 22±2°C and a relative humidity of 40±5% to minimize moisture effects. The quartz filters were weighed on an electronic microbalance with an accuracy of 10^{-6}g before and after sampling, in triplicates. Concentrations of EC and OC were collected on filters were determined using a thermal optical carbon analyzer (TOT, Sunset Laboratory Inc, USA) in an analytical institute. The temperature raising procedures for analysis of EC and OC contents in the present study were similar to the NIOSH method (Birch, 1998).

3. Results and Discussion

3.1. $PM_{2.5}$ concentration

In this study, 24-h average $PM_{2.5}$ concentrations ranged from 6.0 to 67$\mu g/m^3$, with an average of 24.7$\mu g/m^3$. The average concentration of $PM_{2.5}$ exceeded the National Ambient Air Quality Standard (NAAQS) in the USA with annual average of 15$\mu g/m^3$. $PM_{2.5}$ concentrations in the winter time and the spring time were 22.3 and 27.1$\mu g/m^3$, respectively. The higher $PM_{2.5}$ concentration during the spring periods may be due to the emissions from a variety of sources including industrial and traffic activities, and even Asian dust. In the wind rose analysis of two seasons, the spring time has more frequencies of winds coming from industrial areas and traffic areas. However, most of winds in the winter came from south-west and south which may not include significant industrial sources (Fig. 1).

Table 1. Carbonaceous species of $PM_{2.5}$ particles measured in residential area in Ulsan ($\mu g/m^3$).

Sampling period	$PM_{2.5}$	OC	EC	TC
Winter	22.3±10.8	4.6±2.2	1.6±1.0	6.2±3.1
Spring	27.1±16.6	4.2±1.6	1.1±0.3	5.2±1.8
Average	24.7±23.8	4.4±1.9	1.4±0.8	5.7±2.5

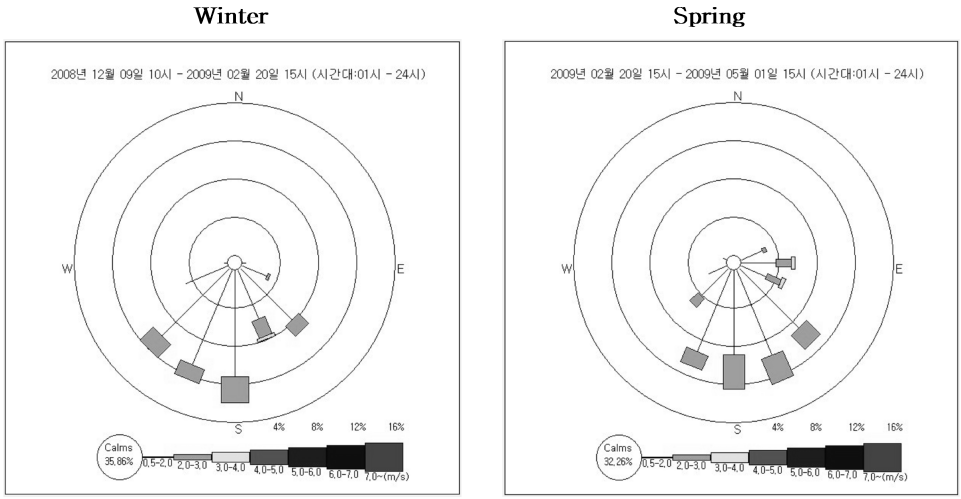

Fig. 1. Average wind rose observed in winter time and spring time at the sampling site.

3.2. Carbonaceous species concentrations

In this study, EC concentrations in $PM_{2.5}$ ranged from 0.5 to 4.0$\mu g/m^3$ with an average of 1.4$\mu g/m^3$, contributing approximately 5.5% to $PM_{2.5}$. OC concentrations varied from 1.6 to 8.3$\mu g/m^3$ with an average of 4.4$\mu g/m^3$, contributing, 17.8% to $PM_{2.5}$. The total carbon (TC) concentrations were calculated by the sum of EC and OC contents. The average TC concentrations in the winter and spring periods were 6.2 and 5.7$\mu g/m^3$, respectively, accounting 27.8 and 21% to $PM_{2.5}$ in winter and spring, respectively. This indicates that total carbon is a significant contributor to $PM_{2.5}$ concentration. The average EC and OC concentrations were higher during the winter compared to the spring and it is probably due to increase in emissions from increased energy consumption and traffic.

Acknowledgements

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