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Metallic elements study of fine and coarse particulates using a versatile air pollutant system at a traffic sampling site

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Abstract

Daytime and nighttime period sampling programs were carried out by a versatile air pollutant system (VAPS) to collect the fine ($PM_{2.5}$) and coarse ($PM_{2.5–10}$) particulates simultaneously at a traffic sampling site in front of Hungkuang University during August to October 2003. Chemical analyses of metallic elements were accomplished by a flame atomic absorption spectrophotometer coupled with hollow cathode lamps. Statistical methods, such as correlation coefficients and principal component analysis (PCA), were used to compare chemical components and to find the possible emission sources at this traffic sampling site. The variations of metallic element concentrations in fine and coarse particulates during daytime and nighttime were also discussed in this study.

Keywords: Coarse particulate; Fine particulate; Traffic; Versatile air pollutant system

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1. Introduction

In Taiwan, more and more vehicles are on the main traffic roads in recent decades. Motor vehicle exhaust ranks as one of the most important sources of fine particulates (Nolte et al., 2002). These fine and ultrafine aerosol particles are often transported long distances, and can reach and penetrate into the lung. They can be enriched in toxic mutagenic and carcinogenic components (Cincinelli et al., 2003). Various types and different operating modes, such as idling, stopping, accelerating, and decelerating, combined with a high density of vehicles at traffic junctions lead to a pollution source problem at traffic junctions (Kumar et al., 2001).

Secondary sulfate, wood combustion, diesel exhaust, secondary ammonium, secondary nitrate, meat cooking, gasoline-powered motor vehicle exhaust, and road dust were responsible for the main components of $PM_{2.5}$ particulate concentrations (mass concentration of particles with aerodynamic diameter smaller than 2.5 μm) (Kleeman and Cass, 2001; Schauer et al., 2002; Zheng et al., 2002). Previous studies indicated that the $PM_{2.5}$ fraction occupied about 61–67% of the PM_{10} (mass concentration of particles with aerodynamic diameter smaller than 10 μm) in central and southern Taiwan while it was about 54–59% in northern Taiwan (Chen et al., 1999). From the point of view of source apportionment, compounds should be considered as tracers only if they occur for all reasonable atmospheric conditions (Fine et al., 2002). The potential $PM_{2.5}$ source categories involve large economic and social consequences when emission controls are considered (Kleeman and Cass, 2001).

Hence, traffic exhaust is the main contributor of finer particulate around traffic areas. The influence of ambient particulate and chemical concentration variations of the daytime and nighttime period are still a great concern. In order to understand the concentration variations of fine ($PM_{2.5}$) and coarse ($PM_{2.5–10}$) particulates during daytime and nighttime sampling periods at the traffic area, a versatile air pollutant system (VAPS) was used to monitor the above pollutants and chemical components attached with them.

2. Materials and method

2.1. Sampling site

The sampling site is located on Chung-Chi Road in front of Hungkuang University (CCRU). Fig. 1 shows the location of the CCRU sampling site in central Taiwan. Chung-Chi Road which connects to Taijunggang Road is a main traffic road which contains a traffic flow of about 3000 and 800 vehicles h^{-1} during daytime (0900–2100 h) and nighttime (2100–0900 h), respectively. The CCRU sampling site is also close to another main highway (Taiwan 2nd Highway).

This sampling site is located in the Sha-Lu Town of Taichung County. And the Chung-Chi road is the main road which connects Taichung City and Taichung County. In addition, Sha-Lu Town is located in the western side of Taichung County. The distance between Sha-Lu Town and Taiwan Strait is about 30 km. Its geological location is 120.5°E, 24.3°N; Sha-Lu Town has a population about 100,000. The choice of these time periods is that