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Metallic elements study on fine and coarse particulates during daytime and nighttime periods at a traffic sampling site

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Abstract

Fine ($PM_{2.5}$) and coarse ($PM_{2.5-10}$) particulates were collected simultaneously by using a versatile air pollutant system at a traffic sampling site during daytime and nighttime sampling periods during August 2003 to March 2004. A flame atomic absorption spectrophotometer coupled with hollow cathode lamps were used for chemical analysis. Enrichment factor and principal component analysis were used to compare chemical components and to find the possible emission sources at this traffic sampling site. The variation of metallic element concentrations on fine and coarse particulates during daytime and nighttime was also discussed in this study. Soil dust, traffic exhaust, marine salt and anthropogenic activities were the major pollutant sources at the traffic sampling site in central Taiwan.

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

1. Introduction

Particulate matter has been noted for its potential adverse health impact in recent decades. Certain toxic compounds in amounts exceeding of natural levels are carried by airborne particles (Sternbeck et al., 2002). PM_{10} (particulate matter whose aerodynamic diameter is smaller than 10 μm) has been widely studied to assess and regulate air quality in many countries (Cincinelli et al., 2003; Salvador et al., 2004). In Taiwan, PM_{10} is one of the major pollutant indexes to estimate the air quality (ROC EPA, 2003). Motor vehicle emissions, fuel combustion from industrial facilities, transportation and construction are major sources of particle pollution in Taiwan (Chen et al., 1999).

The sources, characteristics and potential health effects of coarse particulates are different from those

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of fine or ultrafine particulates. For coarse particles, geological material such as construction, road and soil dust constitute about 50% of PM_{10} (Quiterio et al., 2004). The finer particulates can readily penetrate into the lung and affect the human respiratory system and increase mutagenic diseases (Wang et al., 2002).

Many researchers were interested in the distributions of particle matter and its chemical properties in different regions such as urban, suburban, rural and industrial zones. Most air pollution/source apportionment studies determine total elemental concentrations in airborne particulate matter (Voutsa and Samara, 2002). The concentrations and size distributions of trace metals are governed by the nature of emissions to the atmosphere, as well as by rates of wet and dry deposition, cloud processing and exchange of air between the boundary layer and the free troposphere, and chemical transformations (Allen et al., 2001).

Urban populations are exposed to metals in suspended particles and these are often well above natural background levels owing to anthropogenic processes. This results in elevated metal concentrations that can pose an important risk to human health. Metal transfer through the atmosphere is a significant part of the biogeochemical cycle of these elements (Galloway et al., 1982). There are two processes which increase heavy metal concentrations in the atmosphere: natural and anthropogenic. Understanding emissions from traffic includes identification of the sources, which is also crucial for designing control measures. Road traffic involves numerous potential sources of metals, e.g., combustion products from fuel and oil, wear products from tires, brake linings, bearings, coach and road construction materials, and resuspension of soil and road dust (D'Almeida et al., 1991).

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 of great concern. In order to understand the concentration variation 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 methods

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 Taijung-gang Road, is a main traffic road containing traffic flow of about 3000 and 800 vehicles h^{-1} during

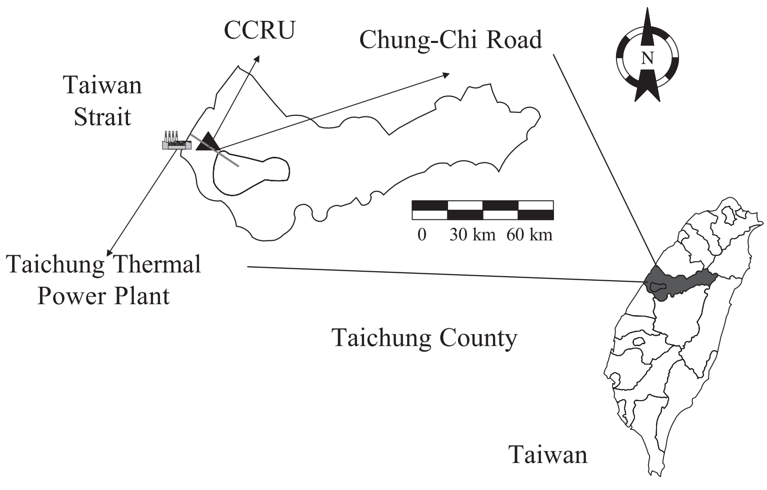

Fig. 1. Location of the sampling site in the safety island of Chung-Chi Road in front of Hungkuang University (CCRU) in central Taiwan.