

Characterization of size-differentiated particle composition of ionic species between Taichung Harbor (TH) and WuChi Traffic (WT) near Taiwan Strait during 2004–2005

Chih-Chung Wen, Guor-Cheng Fang*

Department of Environmental Engineering, HungKung University, Sha-Lu, Taichung 433, Taiwan, ROC

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Abstract

The characteristics of the ionic species concentrations by using appropriate statistical analysis methods and ionic balance equation were investigated in this paper. Size-differentiated ambient air particulates (atmospheric particulate matter of total suspended particulate TSP), fine particle (particle matter with aerodynamical diameter $<2.5\mu\text{m}$, $\text{PM}_{2.5}$), coarse particle (particle matter with aerodynamical diameter $2.5\text{--}10\mu\text{m}$, $\text{PM}_{2.5\text{--}10}$) were collected during March 2004–January 2005 in Taichung Harbor (TH) and WuChi Traffic (WT) near Taiwan Strait by using PS-1 sampler. The result indicated ionic species SO_4^{2-} was both the main components on the TSP and fine particulates at TH and WT sampling sites, and the ionic species Ca^{2+} and NO_3^- were both the main components on the coarse particulates at TH and WT sampling sites during sampling period. By using the method of ionic balance, the results indicated that sulfate is mostly neutralized by ammonia at TH and WT sampling sites in the coarse particle mode. On the contrary, NH_4HSO_4 is the dominant component in the fine particle mode at TH and WT sampling sites.

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1. Introduction

Atmospheric pollution in the Taichung city near Taiwan Strait, mainly due to aerosols (particulate matter, PM), has become a significant issue for its nearly inhabitants. Atmospheric aerosols will reduce the local visibility and have adverse effects on human health (Dockery et al., 1992; Shuetzle, 1983;

Spengler et al., 1990; Dockery et al., 1993). The health-related finds of these studies were associated with either the total mass concentration of suspended particulate (TSP) or the mass concentration of particles with aerodynamic diameters smaller than $10\mu\text{m}$ (PM_{10}) or smaller than $2.5\mu\text{m}$ ($\text{PM}_{2.5}$). In general, inorganic species often include 25–50% of the aerosol mass with major components: sulfates, ammonium and nitrates (Gray et al., 1986). Relatively many observational and previous studies have described that the coastal marine atmosphere adjacent to large urban and industrial centers can be strongly impacted by pollution

*Corresponding author. Tel.: +886 4 2631 8652x1111;
fax: +886 4 2350 2102.

E-mail address: gcfang@sunrise.hk.edu.tw (G.-C. Fang).

emissions, resulting in high loading of pollutants in the ambient air. Another pollution problem is the result of significant high emissions by gasoline engine vehicles and fixed sources (Chester et al., 1994; Scudlark et al., 1994; Baker et al., 1997; Holsen et al., 1997; Ondov et al., 1997; Eisenreich et al., 1997; Gao et al., 2002). Although there is no Taiwan standard for $PM_{2.5}$ (PM with aerodynamic diameter $<2.5\ \mu\text{m}$), the $PM_{2.5}$ levels are well above acceptable limits, using as a reference the US 24 h average standard of $65\ \mu\text{g m}^{-3}$. Atmospheric pollution has become a serious problem in Taiwan. In past decade, emissions of anthropogenic air pollutants have been increasing drastically in Asia (Lee et al., 2001).

The major collected fractions of aerosol particle were the elements of Mg, Al, Si, K, Ca and Fe during dust storms in China (Fan et al., 1996). 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 fine particulate ($PM_{2.5}$) concentrations (Kleeman and Cass, 2001; Schauer et al., 2002; Zheng et al., 2002). In general, it needs to investigate the properties of atmospheric pollution of the composition of inhalable particles (PM_{10}) and fine particles ($PM_{2.5}$) for different aerosol size distributions and the origin of the various particles. In the USA, China, Korea, and Brazil, numerous studies have been carried out whereby the sources and chemical composition of urban and/or rural particles have been investigated.

These studies collected ambient air particulate concentrations at TH and WT near Taiwan Strait in central Taiwan during March 2004–January 2005. The purpose of this paper was to investigate the composition of ionic species at TH and WT sampling sites. Especially, the characterizations of different size particulates of ionic species were not yet widely discussed in central Taiwan. This study was thus focus on the composition of the ionic species and the relation of ion balance and comparison around the world. Most important of all, the air pollutants have become severe during the past decade in Taiwan. TH is a famous harbor in central Taiwan, and it has minimum distances near China. However, the characterizations of air pollutants remain unknown in central Taiwan. Thus, the characterization of size-differentiated particle composition of ionic species and ion

balance has become the most important issue for this study.

2. Meteorological parameters and sampling data

2.1. Sampling sites

TH sampling site and WT sampling site were located in the western side of central Taiwan. Fig. 1 showed the sampling geographical distribution of TH and WT. TH was an artificial harbor and has the maximum amounts of 83 ports, which is located on the west coast of central Taiwan. In TH sampling site, there was set on the roof of a building of four floored building and this site could be characterized as harbor sampling site. In this study, the sampling site was located at the chemical port area which about 100 m on the east side of Taiwan Strait. Another sampling site was located on the east side of Taiwan Strait about 30 km (Fig. 1). WT sampling site was set at the highest building in this region. The sampling height of this sampling site is about 10 m. The sampling sites were at HUNG SUN building, which was near the chemical port and at WuChi Elementary building. They were located on the east side of Taiwan Strait. The traffic flow in WuChi Traffic was about 3,000 vehicles h^{-1} during sampling periods. The WT sampling site was located east side of Taiwan 2nd Highway about 30 km. Diesel trucks and cars constructed the main vehicle flow in this traffic lane. In addition, the Taichung Thermal Power Plant was located east side of TH about 20 km. TH and WT sampling site were collected simultaneously in central Taiwan, Taichung in this study. Atmospheric particulates were consecutive measured at this sampling site during March 2004–January 2005.

2.2. Meteorological data

Meteorological analysis was made by WatchDog weather station Model 525 (Spectrum Technologies, Inc., USA). The weather station can provide data of wind speed, wind direction, temperature and humidity during sampling period.

During the sampling period at both TH and WT, the average temperatures were 21.4 and 24.6 °C, respectively, and the average wind velocities were 9.12 and 7.15 m s^{-1} , respectively. The relative humidity at TH and WT were 82.17% and 73.0%, respectively. The prevailing wind direction was NNW at both TH and WT during this sampling period.

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