Aerosol Loading Effects on Particle Size-selective Samplers

Ting-Ju Chen[1], Yu-Mei Kuo[2], Chih-Wei Lin[1], Sheng-Hsiu Hung[1] and Chih-Chieh Chen[1*]

[1]*Graduate Institute of Occupational Medicine and Industrial Hygiene, National Taiwan University, Taipei, Taiwan.*

[2] *Department of Occupational Safety and Health, Chung Hwa University of Medical Technology.*

Abstract

Increasing attention has been drawn to the adverse health effects of particulate matter less than 2.5 μm ($PM_{2.5}$) over the past several decades. To obtain reliable $PM_{2.5}$ measurements, it is critical to efficiently separate particulate matter less than 2.5 μm in the airstream from the beginning to the end of sampling. However, commonly used separators for $PM_{2.5}$ monitoring, such as the BGI Very Sharp Cut Cyclone (VSCC), are usually subject to aerosol loading effects. This study investigates the loading effect on cyclone separation performance as a function of particle size, cyclone size, particle material, and air humidity. Based on the ratios of dimensions to the body diameter of the BGI VSCC, four cyclones with different body diameters (13-35.6 mm) are fabricated. An ultrasonic atomizer is employed to generate micrometer-sized potassium sodium tartrate (PST) particles and sodium chloride (NaCl) particles as solid challenge particles and di-ethyl-hexyl-sebacate (DEHS) particles as liquid ones. Aerosol particles are neutralized to the Boltzmann charge equilibrium. An aerodynamic particle sizer measures the aerosol distributions and number concentrations upstream and downstream of the cyclones. The experimental results show that solid particles such as PST with sizes close to the cyclone cut-point exhibit a significant loading effect. However, no significant difference is found on aerosol loading effect on for different-sized cyclones. The cyclone separation curve appears to shift toward smaller sizes due to aerosol loading. During the loading test, the aerosol penetration of 2.5-μm particles abruptly decreased, from 50%, at the first 20 minutes to a relatively stable level of 30%, an average decrease of 20%. Thus the performance of cyclone $PM_{2.5}$ samplers with progressive aerosol loading might result in an underestimation of $PM_{2.5}$, particularly for continuous monitoring of particulate matter.

Key words: cyclone; loading effect; penetration.

*Corresponding author. E-mail: ccchen@ntu.edu.tw