FINE PARTICLES SAMPLING OF LIGHT-SCATTERING LASER PHOTOMETER AND AIR SIZER WITH IMPACTION SIZER

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Abstract

In this study, the fine particle concentrations by the light-scattering laser photometer and air sampler with impaction sizer were sampling in the field. The particle capture efficiency of the impaction sizer were examined first due to the particle capture efficiency of impaction sizer in the air sampler is important for fine particles sampling. This study used the tested particles and the aerodynamic particle sizer to measure the particle capture efficiency of the impaction sizer. Results show that the particle capture efficiencies of the impaction sizer with foam material of 9mm thickness are higher than those with 3mm foam material for the jet diameter of 10mm. The numerical results of the particle capture efficiencies of the impaction sizer will compare with those of the experimental data. The fine particle concentrations obtained using the light-scattering laser photometer will be compared to those of air sampler with the impaction sizer.

1 Introduction

The light-scattering laser photometer is a portable monitor for measuring fine particle concentrations in different air environments. Several studies pointed out that the particle concentrations by the light-scattering laser photometer were higher than those by the manual method [1,2]. The concentrations of respirable particulates were measured using the light-scattering laser photometer and a gravimetric method in the indoor environment. Results also showed that the particle concentrations of the light-scattering laser photometer were high correlated with the Federal Reference Method [3]. Their results reported that the particle concentrations by the light-scattering laser photometer were found to be about twice as high as those of air sampler. In addition, the relationships between particle concentrations from a beta gauge monitor and by the light-scattering laser photometer were evaluated at different ambient environments [4]. The results indicated that the fine particle concentrations of the light-scattering laser photometer were higher than those of the beta gauge monitor, whenever the inlet heater of the beta gauge was turned on or off. The particle concentrations of the adjusted light-scattering laser photometer were compared to those of the beta gauge monitor. Results showed that the estimated concentration measurements by the adjusted light-scattering laser photometer can be recalibrated to improve the accuracy of the particle concentrations. Beside, studies have pointed out that collection plat coated with oil in the impaction sizer can keep the particle capture efficiency of the impaction sizer. The collected particles were accumulated on the grease material till long-time loading conditions. Thus, foam impaction sizer has been applied for the fine particles sampling. The impaction sizer with foam substrate inside the air sampler has the characteristics of reducing particulate rebound effect. Its particulate capture efficiency curve does not follow the steep theoretical curve. The particle capture efficiencies of the impaction sizer with larger thickness were found to be higher than those with smaller thickness [5]. In this study, the particle capture efficiency of an impaction sizer were studied experimentally first. Numerical methods will be also used to obtain the particle capture efficiency of the impaction sizer. This work attempts to compare the fine particle concentrations obtained using the light-scattering laser photometer to those of air sampler with the impaction sizer.

2 Methods

Liquid particles were generated by using an ultrasonic atomizing nozzle. An aerodynamic particle sizer was used to measure the aerosol number concentrations at the inlet and outlet of the impaction sizer to test the particle capture efficiency. The flow field in the impaction sizer was then simulated by solving the Navier-Stokes equations in the cylindrical coordinate. The governing equation was discretized by means of the finite volume method. After obtaining the flow field, the particle equations of motion were solved numerically to obtained particle capture efficiency of the impaction sizer. The light-scattering laser photometer and the air sampler with impaction sizer were collocated on a laboratory room to compare the fine particle concentrations. The photometer and the air sampler were placed at about 1.5m above the floor to determine fine particle concentration. The components of the air sampler include an impaction sizer with foam substrate and filter.

3 Results and discussion

In this study, the particle capture efficiency of the impaction sizer were studied experimentally first. Foam substrates were used as the collection material of the impaction sizer with different thicknesses. Foam porosity
of the impaction sizer is 100ppi. Figure 1 displays the particle capture efficiency of the impaction sizer for various jet diameters and foam thicknesses. Results demonstrate that the particle capture efficiencies of the impaction sizer with foam material of 3mm thickness are lower than those with foam material of 9mm thickness for jet diameter of 10mm. Findings also show that the particle capture efficiencies of impaction sizer with foam material decrease as the aerodynamic particle diameter decreased.

5 References

Figure 1 Particle capture efficiency of impaction sizer for different conditions.

The particle capture efficiencies of the impaction sizer using the foam material are higher than those of the flat substrate. In addition, the cut-size of the impaction sizer with foam material for the jet diameter of 8.5mm is found to be smaller than those with foam material of 3mm thickness for the jet diameter of 10mm at same flow rate. This study will perform the numerical calculations for the particle capture efficiencies of the impaction sizer with the foam material. The numerical results of the particle capture efficiencies of the impaction sizer will compare with those of the experimental data. The fine particle concentrations from the light-scattering laser photometer will be compared to those of air sampler with the impaction sizer.

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