Using a Lab-Made Virtual Impactor along with a SKC Button Aerosol Sampler for Classifying and Sampling Indoor Bioaerosol

A. M. Nasrabadi[1], J. Park[1] and J. Hwang [1]

[1]Department of Mechanical Engineering, Yonsei University, Seoul 120-749, Republic of Korea
Keywords: Virtual impactor, Indoor bioaerosol sampling, Bacterial aerosol, Fungal aerosol.
Presenting author email: a.mohamadi@yonsei.ac.kr

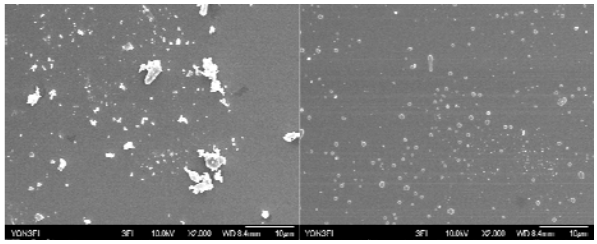
Virtual impactors are extensively utilized to collect, classify, and concentrate aerosol particles. Moreover, keeping particles as airborne after classification make it suitable device for studying airborne microorganisms. In this study, a virtual impactor with the cutoff diameter of 1 µm was designed and fabricated. By using SEM picture the difference sampling particle at inlet and both outlets were investigate. Finally, by combining the virtual impactor with a SKC Button Aerosol Sampler the indoor bioaerosols (bacteria and fungi) in a work office in Seoul was studied. The aim of this study is to determine the weight of the major outlet and fine microorganisms being usually neglected in common bioaerosol samplers.

To design the virtual impactor, computational fluid dynamics simulation was carried out by using ANSYS Fluent to determine an optimal design and also to predict the performance of the virtual impactor. With polystyrene latex particles, experimental tests were carried out to evaluate the performance and validate simulation results. By considering changing the inlet flow rate and also the ratio of minor to total flow rate, cutoff diameter of 635 nm and 1.5 µm also became accessible.

By using a handheld electrostatic precipitator (Miller et al. 2010), airborne particles were sampled over silicon plates at the inlet and both outlets. Fig.1 shows the SEM picture of outlets for the cutoff diameter of 1 µm. Most of the exiting particles from major are single and non-aggregated. However, the minor outlet contains large particles being usually coagulated with finer particles. Passing these particles can obstruct micro channel and make post processing analysis over them much more difficult.

To study fine indoor bioaerosol, indoor field-test was also carried out with the combined sampler to sample airborne bacterial and fungal particles at an office located in Seoul, South Korea. The experiment was performed in the temperature and relative humidity of 32.8– 35 ˚C and 48 – 52 %, respectively. The field-test results showed that 22% of fungal fragments and 40% (Figure 2) of bacterial particles size were smaller than 600 nm (Fig.2).

The field test and SEM results in accompany with previous studies (Cho et al. 2005; Cheng, 1999) showed that the majority part of ambient particle concentration consists of fine microorganisms. Using virtual impactor as a part of sampler gives the possibility to remove coagulated and contaminated particles and make post processing over these particles more uncomplicated.



(a) (b)

Fig. 1 SEM pictures of Minor (a) and Major (b) outlets for the cutoff diameter of 1 µm (Magnification = ×2,000).

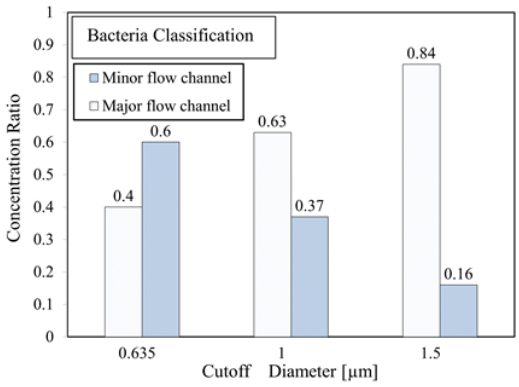


Fig. 2 Size distributions of airborne bacteria of the work office

This work was supported by BioNano Health-Guard Research Center funded by the Ministry of Science, ICT & Future Planning (MSIP) of Korea as Global Frontier Project (2013M3A6B2078959)

Cho, S. H., Seo, S. C., Schmechel, D., Grinshpun, S. A., & Reponen, T. (2005). Aerodynamic characteristics and respiratory deposition of fungal fragments. Atmospheric Environment, 39(30), 5454-5465.

Cheng, Y. S. (1999). Detection of bioaerosols using multiwavelength UV fluorescence spectroscopy. Aerosol Science & Technology, 30(2), 186-201.

Miller, A., Frey, G., King, G., & Sunderman, C. (2010). A handheld electrostatic precipitator for sampling airborne particles and nanoparticles. Aerosol Science and Technology, 44(6), 417-427.

Loo, B. W., & Cork, C. P. (1988). Development of high efficiency virtual impactors. Aerosol Science and Technology, 9(3), 167-176.