The Effect of Surface Charge on Characteristics of Fibrous Membrane

Yu-Rou Jhong[1], Hsin-Ying Lin[1], Sheng-Kai Chan[1], Tsung-Ming Tu[1], Yu-Chih Cheng[1], Yuan-Yi Chang[1], Chun-Wan Chen[2], Wen-Yinn Lin[1,*]

[1]Institute of Environmental Engineering and Management, National Taipei University of Technology, Taipei City 10608, Taiwan.
[2]Institute of Occupational Safety and Health, New Taipei City 22143, Taiwan.
Keywords: fibers; electrostatic; pressure drop
Presenting author email: wylin@ntut.edu.tw

Electrostatic attraction is a kind of basic mechanisms by which an aerosol particle can be collected onto a fiber (Hinds, 1999). Charged fibers can greatly enhance filter collection. Basing on electrostatic mechanisms, a filter can achieve specified collection efficiency at a lower packing density and thereby lower resistances to gas flow in the filter. This can achieve high removal efficiency without a large pressure drop (Nifuku *et al.*, 2001). In spite of many studies have been researching on the surface charge of fiber affects the filtration properties by theoretical simulation; few have been carried out on the experimental result. The objective of this study was to investigate the filtration properties of electrostatic filter.

In this study, an electrospinning system was set up. It was applied to produce fibrous membranes. The filtration test system was shown in figure 1. Fibrous membranes, made of PMMA, were tested to investigate the aerosol filtration characteristics of fabric filters while challenged with polydisperse NaCl particles. A constant output atomizer was used to generate particles. Besides, the aerosol concentrations and size distributions were measured by using an SMPS. The fiber diameter of test fibrous membranes was including 490, 1100, 2040, and 4052 nm. And then the applied voltage of fibrous membranes electrified was 12 kV by using corona discharge.

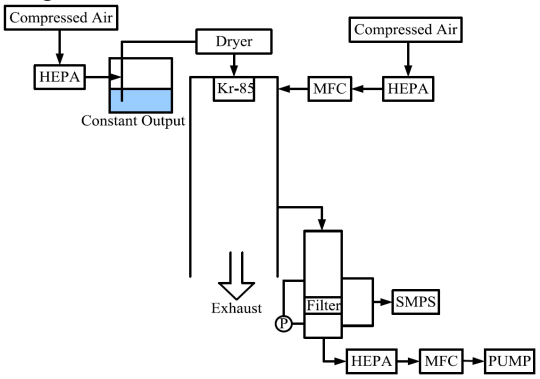

Figure 1. Schematic diagram of test system

The consequence of this study suggested that the morphology of the fibers was smooth and bead-free, which was photographed by scanning electron microscope (SEM), and shown in figure 2.

On the pressure drop test of different fiber diameter fibrous membranes, the effect of various filtration velocities on pressure drop was shown on figure 3. The pressure drop of fibrous membranes was increased as the filtration velocity increased and as the fiber diameter decreased.

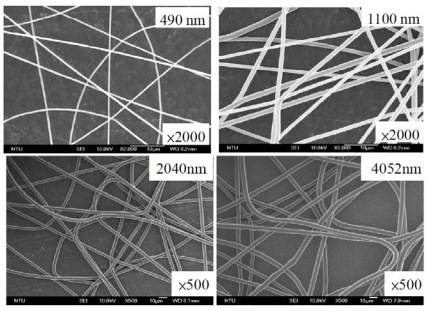

Figure 2. The morphology of fibers (SEM)

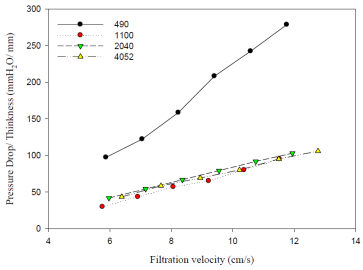

Figure 3. The effect of various filtration velocities on pressure drop

Penetration results of fibrous membranes shown in figure 4. The results suggested that the penetration increased with decreasing the fiber diameter of fibrous membranes.

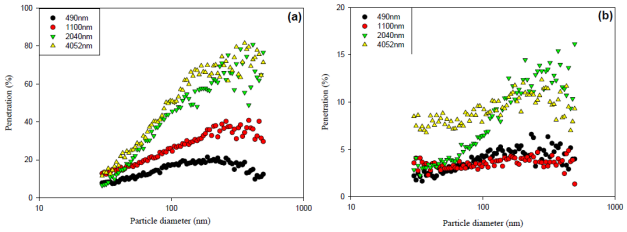

Figure 4 Penetration of fibrous membranes (a) Uncharged (b) Charged

Besides, as using electrostatic fibrous membranes, the penetration was significantly reduced. The filter quality could be improved by installing electrostatic fibrous membranes.

William-C Hinds, (1999), "Aerosol Technology," *New York: WILEY-INTERSCIENCE*.

Nifuku, M. Zhou, Y. Kisie, A. Kobayashi, T. Katoh, H. (2001) "Charging characteristics for electret filter materials," *Journal of Electrostatics*, Vol. 51-52, pp. 200-205.