

AEROSOL FILTRATION BY FILTERS PRETREATED WITH IONIC SURFACTANTS

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INTRODUCTION

Most people spend as much as 87.2% of their time indoors where exist several indoor air pollutants (Lance, 1996). Among those contaminants, indoor suspended particulate is a serious problem because it could cause the respiratory diseases for humans. Therefore, many air-cleaning devices have been used remove the particulate matters. Recently, the electret filters have been a commonly air cleaner due to the increased filtration efficiency without a corresponding increase in pressure drop. In the present study, the charged filters are prepared by using discharged filters treated with ionic surfactants. In the past, this process is often applied in water filtration (Kang and Shin, 1997). Our previous study has indicated that the filter can be charged by treating with ionic surfactants in air filtration (Yang and Lee, 2001). However, we only investigated the filter pretreated with surfactants at one concentration. This study examined the effects of the different ionic surfactants concentrations on the aerosol penetration of the pretreated filter. In addition, the effects of aerosol types, aerosol charged state, relative humidity, aerosol charge state, and surfactant type (cationic and anionic) we also evaluated.

EXPERIMENTAL METHODS

The experimental system consists of filter media, aerosol generation, and filter test section. Polypropylene fibrous filter is treated with dimethyl dioctadecylammonium bromide (DDAB, cationic) and sodium oleate (SO, anionic) to create the positive and negative charged filter, respectively. The first step of filter treated process is dissolving the surfactant in two-tailed water. Then the filters were soaked in the surfactant solution for 15 minutes and coated with the surfactants. This is because the surfactants have one or several hydrocarbon chains that can hydrophobically bond to the surface of the polypropylene (Kang and Shah, 1997). Sodium chloride (NaCl) and di-2-ethylhexyl-sebacate (DEHS) were chosen as the solid and liquid test aerosols. The test aerosol was generated in polydisperse state by a Collison atomizer. Then the polydisperse aerosol was classified electrically by a Differential Mobility Analyzer (DMA), to obtain the monodisperse singly charged aerosol in the submicrometer-sized range of 0.05 to 0.5 μm . The singly charged aerosol was positively charged, because the inner electrical rod of the DMA connected to a negative power supply provides a precise negative potential to attract aerosol with positive charge. By changing the negative power supply to positive power supply, the DMA could produce the negatively charged particles. The aerosol from the DMA was passed through a Kr-85 radioactive source, which neutralized the aerosol to the Boltzmann charge equilibrium (neutral particle). The aerosol penetration of the filters was measured by two condensation particle counters (CPCs), measured the aerosol concentrations upstream and downstream of the filter. The face velocity through the filter was controlled by a flow meter and pump.

RESULTS AND DISCUSSION

Figure 1a-b show that the aerosol penetration of the NaCl neutral particles for three different concentration SO and DDAB pretreated filter as a function of particle size at face velocity of 10 cm/s. Figure 1a showed that the aerosol penetrations of 0.3- μm aerosol through the 0, 0.01, 0.05, and 0.08M SO pretreated filters are 75%, 51%, 47%, and 41%, respectively. Similarly, the 0, 0.005, 0.01, and 0.02M DDAB pretreated

filters give the penetration of 0.3- μm aerosol of 75%, 53%, 48%, and 34% shown in Figure 1b. The aerosol penetration of the untreated filter is higher than surfactant pretreated filter. This is due to the filter become charged by treating with the ionic surfactants. The reason is possible that when ionic surfactant dissolved in the water, its hydrocarbon carbon chain of the ionic head group would bond with polypropylene fibrous filter, which would be coated on the filter while the filter left the solution. Parts of those ionic head groups do not bond with the opposite charge ions that creates filters become charged. The aerosol penetration of the pretreated filter appears to decrease with the surfactant concentration. It indicates that the electrostatic capture force increases with the increasing of surfactant concentration. This may be that the coated number of ionic head groups on the filter increases with the surfactant concentration. This phenomenon makes the surface fiber charge increases and electrostatic force becomes stronger. In comparison with the aerosol penetration of 0.01M SO and DDAB pretreated filters, the DDAB pretreated filter has lower penetration than SO pretreated filter. It is likely that DDAB has one more hydrocarbon carbon chain than SO to hydrophobically bond with polypropylene filter. Therefore the coated number of ionic head groups from DDAB molecules on the filter is greater than from SO molecules at the same solution concentration that causes the surface fiber charges of DDAB pretreated filter to be higher.

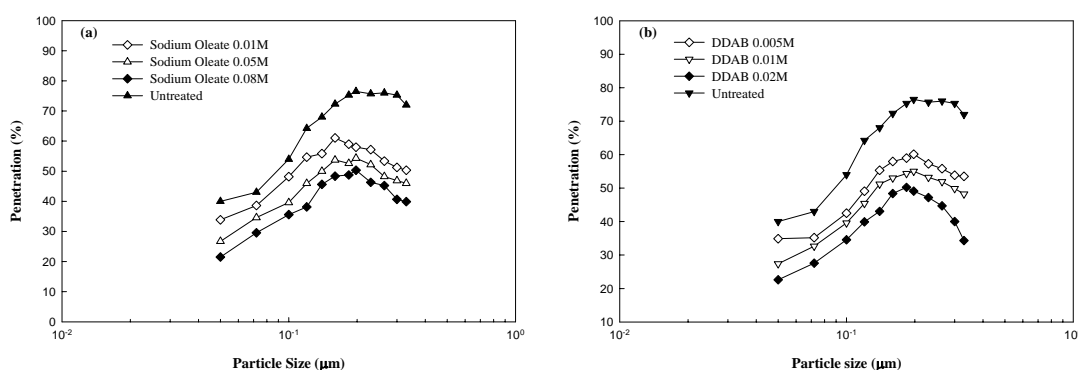


Figure 1. Aerosol penetration of the NaCl neutral particles on the surfactant pretreated filter versus particle size for face velocity of 10 cm/s. (1a. SO pretreated filter; 1b. DDAB pretreated filter)

CONCLUSIONS

The experimental results showed that the aerosol penetration decreases with the surfactant concentration increasing due to the surface fiber charges increase with the increasing of coating weight of the surfactant on the filters. The results also indicated the DDAB pretreated filter has the lower penetration than SO pretreated filter in the same concentration.

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