S3.4.1 Capture of Sub-500 nm Nanoparticles Using Residential Electret HVAC Filter Media-Experiments and Modeling

Deqiang Chang[1], Sheng-Chieh (Shawn) Chen[2], David Pui[2]
[1]Northeastern University, [2]University of Minnesota

Electret HVAC filter media are widely used to remove airborne particles in residential or commercial indoor environments. Based on ICRP deposition model, sub-500 nm particles have an enhanced deposition in the tracheobronchial region and the alveolar region. In this study, five residential electret filter media were challenged with mono-disperse silver and potassium chloride nanoparticles of 3-500 nm at different face velocities for their initial efficiency. The theoretical filter efficiencies were also studied and compared with data for the validation of future application of better filter designs. For further understanding the effect of fiber charges on particle collections, electret media were discharged and the efficiencies acquired from pure mechanical mechanisms were compared with that of electret media. The figure of merit (FOM) was investigated for both original and discharged electret media to evaluate the filtration performance more detailedly. Experimental results showed that the Most Penetrating Particulate Size (MPPS) moved to the smaller particle size range with increasing face velocity. MPPSs shift to the smaller particle sizes with increasing face velocity. At face velocities of 0.5 to1.5 m s-1, clear bi-modal penetration curves were observed, peaking at 10 ~ 25 and 150 ~ 200 nm, respectively. For highly charged filter, the first mode is higher than the second one while it shows reverse trend for medium charged filter. Both comparisons for filtration efficiency and FOM between original and discharged media showed that electret filter was more effective than mechanical filter for capturing particles with size of 15 to 200 nm and these filters may not be used at high face velocities if high capture efficiency was expected. By considering the polarization forces for charged particles, the single fiber theory predicted the particle penetrations well for all size range and the model could be used to improve the design of filter.