

# Evaluation of Filter Media for Particle Number, Surface Area and Mass Penetrations

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The National Institute for Occupational Safety and Health (NIOSH) developed a standard for respirator certification under 42 CFR Part 84, using a TSI 8130 automated filter tester with photometers. A recent study showed that photometric detection methods may not be sensitive for measuring engineered nanoparticles. Present NIOSH standards for penetration measurement are mass-based; however, the threshold limit value/permissible exposure limit for an engineered nanoparticle worker exposure is not yet clear. There is lack of standardized filter test development for engineered nanoparticles, and development of a simple nanoparticle filter test is indicated. To better understand the filter performance against engineered nanoparticles and correlations among different tests, initial penetration levels of one fiberglass and two electret filter media were measured using a series of polydisperse and monodisperse aerosol test methods at two different laboratories (University of Minnesota Particle Technology Laboratory and 3M Company). Monodisperse aerosol penetrations were measured by a TSI 8160 using NaCl particles from 20 to 300 nm. Particle penetration curves and overall penetrations were measured by scanning mobility particle sizer (SMPS), condensation particle counter (CPC), nanoparticle surface area monitor (NSAM), and TSI 8130 at two face velocities and three layer thicknesses.

Results showed that reproducible, comparable filtration data were achieved between two laboratories, with proper control of test conditions and calibration procedures. For particle penetration curves, the experimental results of monodisperse testing agreed well with polydisperse SMPS measurements. The most penetrating particle sizes (MPPSs) of electret and fiberglass filter media were ~50 and 160 nm, respectively. For overall penetrations, the CPC and NSAM results of polydisperse aerosols were close to the penetration at the corresponding median particle sizes. For each filter type, strong power-law correlations between the penetrations measured by different instruments show that the NIOSH TSI 8130 test may be used to predict penetrations at the MPPS as well as the CPC and NSAM results with polydisperse aerosols. It is recommended to use dry air (<20% RH) as makeup air in the test system to prevent sodium chloride particle deliquescing and minimizing the challenge particle dielectric constant and to use an adequate neutralizer to fully neutralize the polydisperse challenge aerosol. For a simple nanoparticle penetration test, it is recommended to use a polydisperse aerosol challenge with a geometric mean of ~50 nm with the CPC or the NSAM as detectors.