Filter Collection Efficiency for Nanoscale Particles

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Nanotechnology, which involves the manipulation of matter at nanometer length scales to produce new materials, structures and devices, is often likened to the new industrial revolution of today. The potential for new products leading to improvements in our lives is astounding. These tiny particles often behave much differently than bulk samples of the same material, resulting in unique electrical, optical, chemical, and biological properties. This same uniqueness in the behavior of engineered nanoparticles leads one to wonder about potential health hazards posed to workers or users that are exposed to them.

Many factors must be considered when trying to assess the health risk posed by any substance. How toxic is the material? Does toxicity depend on particle size, surface chemistry, or other variables? In what form does it exist during manufacture or use? In the case of particles, do they exist as small singlets or agglomerate quickly to a larger, more manageable size? How many people are exposed to the material? At what levels does it exist in the workplace or wherever used? What are the routes of entry into the human body? How effective are the body's defense mechanisms against the material? What are the dose response relationships? What exposure levels are safe? Are existing engineering controls and personal protective equipment adequate? Most of these questions pertaining to engineered nanoparticles remain unanswered.

The work described in this report addresses only the particle collection performance of respirator filters. Recent studies, some published and some anecdotal, have suggested that very small (<20nm) nanoparticles may be able to penetrate commonly used respirator filter media to a greater degree than traditionally assumed. The National Institute for Occupational Safety and Health's National Personal Protective Technology Laboratory (NPPTL) funded the University of Minnesota to test various respirator filter media with various size nanoparticles generated in the laboratory. The results provide information about filter collection performance for particles at the low end of the particle size spectrum, normally assumed to be efficiently collected by diffusion.

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