Environmental Health Committee (EHC) Emerging Issue Report:

Nano Environmental Health and Safety (nanoEHS)

What is the issue?

Nanoscience and nanotechnology are the study and application of extremely small objects. They can be useful across all fields of science including chemistry, medicine, electronics, and material performance because of the unique physical, chemical, mechanical, and optical properties that naturally occur at the nanoscale[1]. Nanoscale typically references to particles that are approximately 1 to 100 nanometers (nm).

In general, there are two (2) broad types of nanoparticles: incidental and engineered. Incidental airborne nanoparticles (diameters less than 100 nm), also referred to as ultrafine particles, are common in indoor air. Sources include ambient air, cooking and the operation of electric appliances. These incidental nanoparticles have been associated with health risks of their own[2], but it is not clear if these risks are associated with the composition, size or shape of these particles, nor is it clear that the risks are fundamentally different for engineered nanoparticles.

Engineered nanoparticles (ENMs) on the other hand are manufactured materials, and there are a growing number of concerns about the potential hazards associated with these particles. Nanomaterials are being used in a range of applications. Examples include cosmetics and sunscreens, paints and coatings, food science, water purification, agriculture and clothing. New and promising applications are being developed at a rapid pace. Some nanotechnology applications, such as carbon nanotubes, have been in use since 1990's. However, there has been a substantial growth in published patent literature and issued patents since 2003[3].

As nanotechnology is developed and as nanomaterials are increasingly used in numerous consumer products and industrial applications, the potential for direct human exposure through dermal, ingestion and inhalation routes increases. Thus the need to understand and address the associated health and safety issues has been recognized as key to their responsible development and use[4]. Exposure to engineered nanomaterials can be anticipated during manufacturing, application, product or material use, disposal and in-use damage such as that induced by fire and water damage.

While definitive health and safety risks for human exposure have not yet been identified, negative respiratory effects have been observed in laboratory animal studies. While regulations do not exist for this size class of ambient air particles, the EPA recognizes ultrafine PM as an emerging issue. Research on health effects and controls are underway to characterize the potential risk for human exposure. NIOSH has published recommended exposure limits (REL) for carbon nanotubes (CNT)[5] and titanium dioxide (TiO_2)[6] in response to potential environmental, health and safety (EHS) issues. These REL's attempt to account for airborne human exposure throughout these products' lifecycle but more guidance may still be needed on potentially hazardous nanoparticles.

What does it mean to ASHRAE?

Predicting health risks of a substance is complicated and there are gaps in the evidence surrounding the health effects of ENMs[7]. Based on the limited available research and exposure data, the precautionary principle should be invoked when these products are being manufactured or in public use because of their unique properties and potential adverse impact on indoor air quality and human health. Therefore, airborne exposures should be kept as low as reasonably practicable. Based on the need to minimize airborne exposure, source recognition and control including engineering controls should be a priority[8]. Also, as field measurements of engineered nanoparticles are conducted, it will be important to account for the background levels of incidental nanoparticles.

What action should be considered?

This is the critical time for ASHRAE to be actively participating in the development of solutions to address nanoEHS health and safety concerns within the scope of its knowledge and activities. ASHRAE should:

- Develop a description of the varied applications of nanomaterials in consumer products, commercial building materials and industrial applications, and the concerns that have been expressed about nanoEHS in indoor environments. Publish this information in the ASHRAE Journal and use it to support future EHC program sessions at ASHRAE conferences.
- Study and develop recommendations for design and control measures based on sound research findings on the role of building, ventilation and filtration system design and operation on the different airborne levels of nanoparticles. This is of importance given that building occupants are already exposed to incidental nanoparticles and have been since long before the recent development of engineered nanoparticles. Technologies involving filtration can be part of the solution to elevated airborne levels of nanoparticles. This situation will likely become more important as products containing nanomaterials become widespread.
- Address the challenges in understanding the behavior of nanoparticles in the environment by supporting research that will measure airborne nanoparticle levels and will develop the proper interpretation of these analytical results. Many of the technologies being developed to find uses for nanoparticles in products can also be useful in characterizing their airborne levels. There is also considerable attention being paid to the issue of measuring nanoparticles in the air which can be developed into ASHRAE-supported research projects.
- Support industry, allied professional organizations and government efforts to develop research projects addressing nanoEHS.

References

[1] National Nanotechnology Initiative, www.nano.gov.

[2] http://enhs.umn.edu/current/5103/particles/humanhealth.html

[3]MsDermott, Will & Emery. 2013 Nanotechnology Patent Literature Review: Graphitic Carbon-Based Nanotechnology and Energy Applications Are on the Rise. February 2014.

[4] Nanotechnology Initiative (NNI) 2011 Environmental, Health, and Safety (EHS) Research Strategy, National Science and Technology Council, Committee on Technology, Subcommittee on Nanoscale Science, Engineering and Technology, www.nano.gov/sites/default/files/pub_resource/nni_2011_ehs_research_strategy.pdf

[5]Occupational Exposure to Carbon Nanotubes and Nanofibers http://www.cdc.gov/niosh/docs/2013-145/pdfs/2013-145.pdf

[6]Occupational Exposure to Titanium Dioxide http://www.cdc.gov/niosh/docs/2011-160/pdfs/2011-160.pdf

[7]Engineered Nanomaterials at the Work Site
http://work.alberta.ca/documents/WHS-PUB_gh019.pdf

[8]Current Strategies for Engineering Controls in Nanomaterial Production and Downstream Handling Processes
http://www.cdc.gov/niosh/docs/2014-102/pdfs/2014-102.pdf

Bibliography

Nanotechnology: Health and Environmental Risks, 2nd Edition, Shatkin, 2013

NIOSH. 2013. Filling the Knowledge Gaps for Safe Nanotechnology in the Workplace A Progress Report from the NIOSH Nanotechnology Research Center, 2004–2011, http://www.cdc.gov/niosh/docs/2013-101/pdfs/2013-101.pdf

Rim, D., L. Wallace, et al. (2012). "Reduction of exposure to ultrafine particles by kitchen exhaust hoods: The effects of exhaust flow rates, particle size, and burner position." Science of the Total Environment 432: 350-356.

Rim, D., M. Green, et al. (2012). "Evolution of Ultrafine Particle Size Distributions Following Indoor Episodic Releases: Relative Importance of Coagulation, Deposition and Ventilation." Aerosol Science and Technology 46: 494-503.

Wallace, L., F. Wang, et al. (2008). "Contribution of Gas and Electric Stoves to Residential Ultrafine Particle Concentrations between 2 and 64 nm: Size Distributions and Emission and Coagulation Rates." Environmental Science & Technology 42: 8641-8647.