World Academy of Science, Engineering and Technology
International Journal of Health and Medical Engineering
Vol:12, No:03, 2018

Nanoparticle Exposure Levels in Indoor and Outdoor Demolition Sites

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Abstract : Working or living close to demolition sites can increase risks of dust-related health problems. Demolition of concrete buildings may produce crystalline silica dust, which can be associated with a broad range of respiratory diseases including silicosis and lung cancers. Previous studies demonstrated significant associations between demolition dust exposure and increase in the incidence of mesothelioma or asbestos cancer. Dust is a generic term used for minute solid particles of typically <500 µm in diameter. Dust particles in demolition sites vary in a wide range of sizes. Larger particles tend to settle down from the air. On the other hand, the smaller and lighter solid particles remain dispersed in the air for a long period and pose sustained exposure risks. Submicron ultrafine particles and nanoparticles are respirable deeper into our alveoli beyond our body's natural respiratory cleaning mechanisms such as cilia and mucous membranes and are likely to be retained in the lower airways. To our knowledge, how various demolition tasks release nanoparticles are largely unknown and previous studies mostly focused on course dust, PM2.5, and PM10. General belief is that the dust generated during demolition tasks are mostly large particles formed through crushing, grinding, or sawing of various concrete and wooden structures. Therefore, little consideration has been given to the generated submicron ultrafine and nanoparticles and their exposure levels. These data are, however, critically important because recent laboratory studies have demonstrated cytotoxicity of nanoparticles on lung epithelial cells. The above-described knowledge gaps were addressed in this study by a novel newly developed nanoparticle monitor, which was used for nanoparticle monitoring at two adjacent indoor and outdoor building demolition sites in southern Georgia. Nanoparticle levels were measured (n = 10) by TSI NanoScan SMPS Model 3910 at four different distances (5, 10, 15, and 30 m) from the work location as well as in control sites. Temperature and relative humidity levels were recorded. Indoor demolition works included acetylene torch, masonry drilling, ceiling panel removal, and other miscellaneous tasks. Whereas, outdoor demolition works included acetylene torch and skid-steer loader use to remove a HVAC system. Concentration ranges of nanoparticles of 13 particle sizes at the indoor demolition site were: 11.5 nm: 63 – 1054/cm³; 15.4 nm: 170 – 1690/cm³; 20.5 nm: 321 – 730/cm³; 27.4 nm: 740 – 3255/cm³; 36.5 nm: 1,220 – 17,828/cm³; 48.7 nm: 1,993 – 40,465/cm³; 64.9 nm: 2,848 – 58,910/cm³; 86.6 nm: 3,722 – 62,040/cm³; 115.5 nm: 3,732 – 46,786/cm³; 154 nm: 3,022 – 21,506/cm³; 205.4 nm: 12 – 15,482/cm³; 273.8 nm: <LOD – 8,405/cm³; and 365.2 nm: <LOD – 4,553/cm³. Concentration ranges of nanoparticles of 13 particle sizes at the outdoor demolition site were: 11.5 nm: 62 – 432/cm³; 15.4 nm: 342 – 732/cm³; 20.5 nm: 224 – 706/cm³; 27.4 nm: 370 – 923/cm³; 36.5 nm: 526 – 1127/cm³; 48.7 nm: 680 – 1,260/cm³; 64.9 nm: 759 – 1284/cm³; 86.6 nm: 716 – 1,245/cm³; 115.5 nm: 539 – 954/cm³; 154 nm: 294 – 445/cm³; 205.4 nm: 3 – 124/cm³; 273.8 nm: <LOD – 22/cm³; and 365.2 nm: <LOD – 32/cm³. Collected preliminary data indicated that concentration of nanoparticles of most categories was higher in indoor demolition sites when compared with outdoor demolition sites.

Keywords : demolition dust, industrial hygiene, aerosol, occupational exposure
Conference Title : ICOHS 2018 : International Conference on Occupational Health and Safety
Conference Location : Miami, United States
Conference Dates : March 12-13, 2018