Capturing the Particle Size Distribution of Emissions During Material Testing and Processing

Application Note NANOSCAN-001 (A4)

Measuring exposure to nanoparticles has typically been conducted as academic research using high-end instrumentation and sophisticated software. For many applications, e.g., in the field of Indoor Air Quality and Occupational Health and Safety, this may not be necessary. A case study on material exposure measurements is presented here. Data were collected to analyze worker exposure during material tests of abrasion and extrudability. In addition, the same measurements were done during milling of the material.

The graphs highlight the averaged differences between background particle concentration in indoor air and exposure during material processing. Background particles were measured in each laboratory and at several sampling points within these rooms. Exposure to nanoparticles was measured in the breathing zone. By averaging the particle concentration at all locations, the nanoparticle concentration was found to be twice as high as the background, with dominant peaks around 15 and 37 nm. The background signal showed a third peak around 116 nm, which is in the range of common indoor aerosols. Individual rooms and processes showed individual emissions, demonstrating the utility of a measurement technique to characterize exposure from multiple processes or locations.

All data shown here were acquired using the NanoScan SMPS™, TSI® Model 3910. This instrument utilizes proven technology based on the science of electrical mobility particle sizing. Nanoparticles are charged, classified according to their charge/size ratio, and subsequently counted by a particle counter, which grows these small particles to an optically detectable size by condensing liquid on their surface. The resulting number distribution is based on a mobility equivalent diameter.

Figure 1 below shows averages of all background data recorded from the ventilation diffusers supplying fresh air to the laboratories compared to the average particle counts measured in the breathing zone for all processes.

Figure 2 highlights the efficiency of safety measures like enclosures with regard to their influence on particle concentration measured in the breathing zone.

Figure 3 shows a safe milling process with no contribution to nanoparticle exposure.

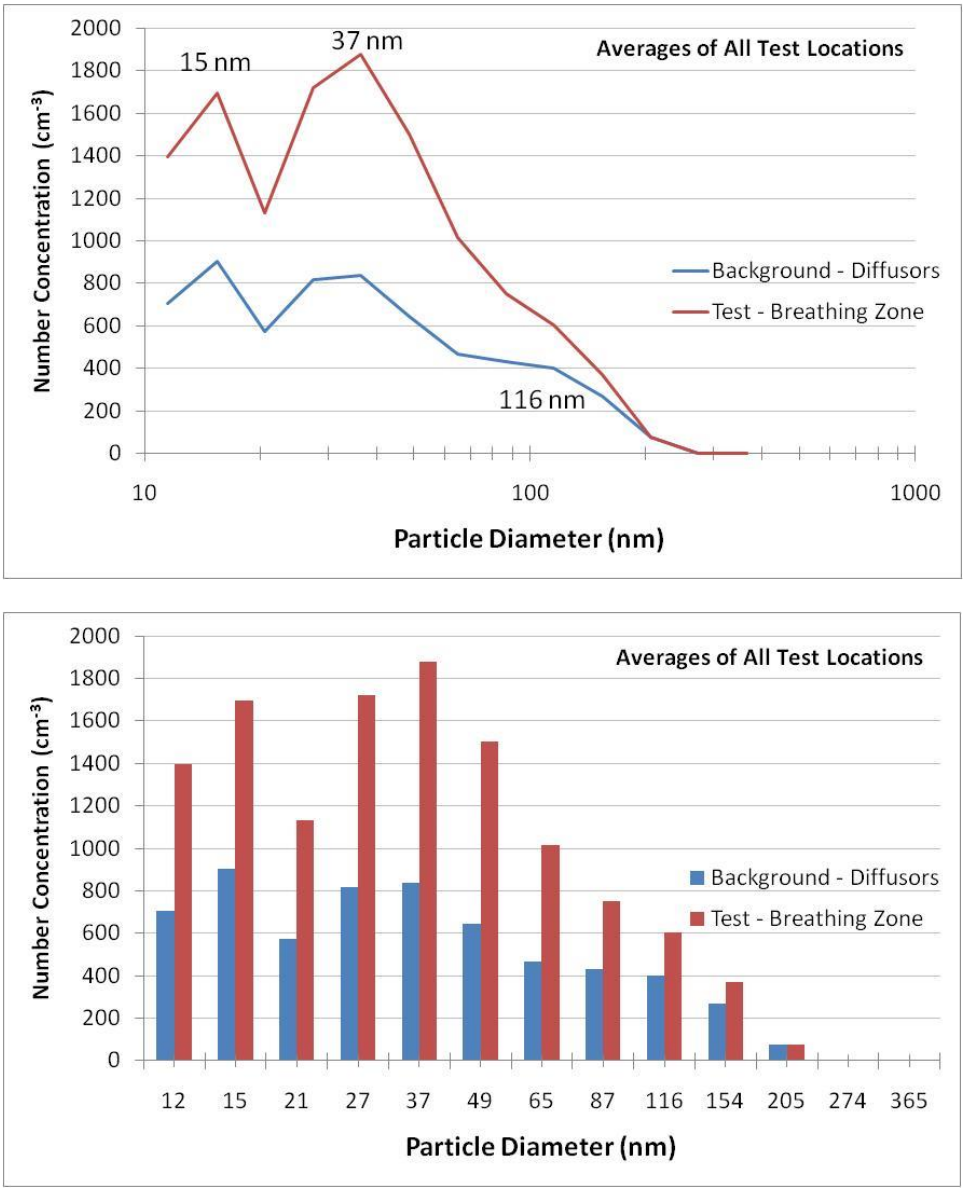

Figure 1: Nanoparticles in indoor air measured in material production and test facility.

The total number concentration in the fresh air supplied through diffusers from the ventilation system was found to be around 6100 per cm^3 for nanoparticles (< 0.5 µm). During the various processes, the total number concentration of particles in the breathing zone was around 12,000 per cm^3. The blue line represents data taken from the ventilation diffusers and shows peaks at around 15, 37, and 116 nm. The red line represents data taken in the breathing zone during material processing. The peaks at 15 and 37 nm became dominant, and the total number concentration measured increased by a factor of 2. Both graphs display the same data in two different ways.

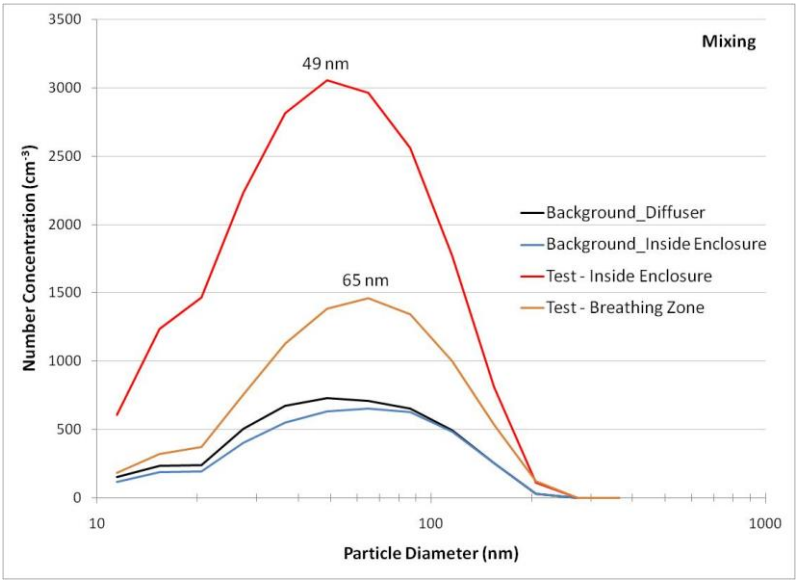

Figure 2: Nanoparticle emissions during a composite mixing process.

Mixing took place in a ventilated enclosure. The particle counts in room air were measured at the ventilation diffuser and were equal to the background in the enclosure; total number concentration was ca. 4700 per cm^3. As the material was processed, the number concentrations within the enclosure increased to ca. 20,000 per cm^3. The enclosure was able to capture most of the emitted particles, but ca. 8600 per cm^3 were measured in the breathing zone, nearly twice as many as the background.

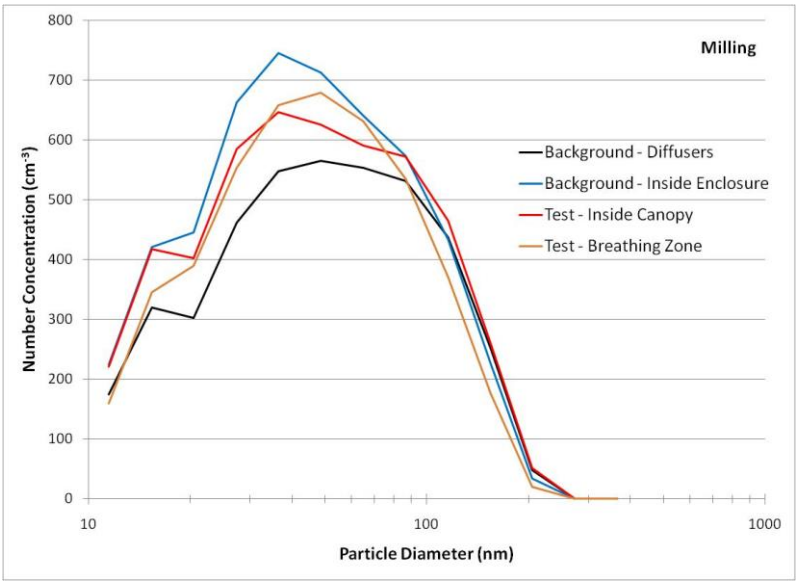

Figure 3: Nanoparticle emissions during a milling process.

Milling took place under a canopy. The particle counts in room air were measured at the ventilation diffuser and were equal to the background in the enclosure; total number concentration was ca. 4200 to 4900 per cm^3. The results indicate that there were no significant nanoparticle emissions

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