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Performance of ventilation mechanical filters for particles smaller than 300 nm MPPS

In the workplace, air quality measurements have revealed a growing presence of ultrafine particles in ambient air. These are mainly due to the growing use of nanoparticles in industry and to dust emissions during manufacturing processes. These ultrafine particles have a very high specific surface area, and numerous studies have shown that some have, for the same mass, increased biological activity, leading to higher toxicity than particles of the same chemical composition, but larger in size. Emissions of these ultrafine particles require the implementation of appropriate exposure control strategies in the workplace. In most situations, contaminant reduction through the use of ventilation systems is the most practical solution. Filtration on fibrous media can achieve high efficiencies in the presence of ultrafine particles, making it the most widely used process in industrial environments. However, according to current standards (ANSI/ASHRAE 52.2 or ISO 16890), ventilation filters efficiency is tested for particles ranging from 0.3 to 10.0 micrometers. Performances of entire filters for nanoparticles are still very limited and particle size of 300 nanometer (0.3 micrometer) is commonly used as the most penetrating particle size (MPPS) for mechanical media.

The main purpose of this project was therefore to develop a measurement procedure to evaluate performance of filters used in ventilation systems for filtering particles smaller than 300 nanometers, including ultrafine particles. The originality of this work is based on obtaining reproducible size-dependent efficiency measurements for particles smaller than 300 nm. To this end, a test bench was designed and validated, and a measurement procedure developed to determine the performance of mechanical filters. The performance of five different mechanical filters (from MERV 8 to HEPA) was then evaluated in terms of penetration and pressure drop and for a large range of particle size.

Experimental data permit to evaluate the MPPS for these mechanical filters. The results have shown that the data are in good agreement with the MPPS theory. It has also been shown that the 150-500 nm range provides a better estimation of the MPPS under the conditions tested. In addition, filtration velocity influences efficiency for nanoparticles at 50 nm but no effect was observed for MPPS. In the context of workplaces, exposures to nanometric materials thus seems effectively reduced by the use of these mechanical filters. However, the question remains as to what is the acceptable performance value for filters that would protect workers in the case of nanoparticle exposure.

Primary author: BROCHOT, Clothilde (Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST))

Co-author: Dr BAHLOUL, Ali (Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST))

Presenter: BROCHOT, Clothilde (Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST))