EXPLICIT EXPRESSIONS FOR THE MINIMUM EFFICIENCY AND MOST PENETRATING PARTICLE SIZE OF NUCLEPORE FILTERS

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ABSTRACT

Nuclepore filters are capillary pore membrane filters with an array of microscopic cylindrical holes of uniform diameters. Their structure is suitable for particle collection and ensuing offline analyses, therefore they are being widely used for exposure assessment of engineered nanoparticles, ambient $PM_{2.5}$, virus, bacteria, asbestos, etc., as well as in powder manufacturing industries. However, there exists a particle size range in which all the filtration capture mechanisms are not effective. This size is the most penetrating particle size (MPPS), which corresponds to the minimum efficiency (ME) of the filter. Both MPPS and ME are important parameters for a user to select an adequate Nuclepore filter and preferred operating conditions. For rapid estimation of the MPPS and ME, we derived their explicit expressions by simplifying the formulas for the impaction, diffusion and interception deposition and differentiating the combined efficiency with respect to the particle size. The comparison between the experimental data and the prediction from the explicit expressions shows the explicit expressions can provide MPPS for a wide range of filter properties (pore radius, porosity and length) and filtration conditions (particle density, face velocity and temperature). The ME can also be estimated satisfactorily when a simplified term of filter surface diffusion deposition is further considered. By the explicit expressions of MPPS and ME, a quick screening for selecting a Nuclepore filter with the proper properties and suitable filtration conditions can be easily achieved. From the theoretical point of view, the explicit expressions facilitate better understanding of the effects of filter properties and conditions on the filtration characteristics.

KEYWORDS

Exposure Assessment, Nuclepore Filter, Most Penetrating Particle Size, Minimum Efficiency, Explicit Expression