Characterization of Filter Materials for Aerosol Research – Size Resolved Penetration

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Characterization of filter materials for aerosol research – size resolved penetration

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Generally, various types of filtration material can be met in many moments of everyday life (air filtration in offices and cars; personal, medical and military respirators, etc.). In aerosol science the filtration material is used for aerosol sampling (sampling heads) as well as for production of clean particle-free air (HEPA filters). Therefore it is necessary to know the size resolved penetration (counterpart of filtration efficiency) of these materials for various reasons (ventilation standards, medical care, military purposes, scientific concerns).

Information available from filter manufactures, a background of a decision on which filter to use for the specific purposes, is usually not detailed enough. The description, if available at all, typically includes characteristics like filter type, thickness, wettability, air resistance, gravimetric extractables and porosity (Millipore, 2001). However, the only information concerning aerosol particles' penetration is the total penetration of di-octylphalate (DOP) or paraffin oil. These measurements are based on very well-known standards (NIOSH or EN) describing how to perform the testing of filter efficiency, such as EN 1822 for HEPA and ULPA filters; EN 143 and 149 for respirators.

Unfortunately all these standardized tests bring several issues. First of all, the filters are challenged with polydisperse aerosols with given Count Median Diameter (CMD) positioned close to the Most Penetrating Particle Size (MPPS), assumed to be at 300 nm in diameter. Moreover, these tests measure only overall penetration giving no information about the real MPPS that is often shifted towards smaller diameters. It also means that the standard omits the fact that penetration is a function of particle size. Secondly, the measurements are usually performed using optical particle counters, OPCs, having their lower detection limit as high as 100 nm. Thirdly, one of the solutions prescribed in the EN 1822 for the aerosol generations, is sodium chloride, NaCl. Shape of these particles (cubical shape for NaCl) does not fully comply with the commonly used theoretical assumption in aerosol science – spherical particles (e.g. when we select monodisperse particles in the DMA).

Therefore, taking into account all the previously mentioned issues, the results of such an analysis based on standardized methods give only limited information about penetration of tested filter material. Considering both importance of filters for ongoing aerosol research and unsatisfactory description of filters filtration efficiency, aim of this work is to define size dependent penetration through filter material of the most often used filters in aerosol research.

In order to obtain detailed size resolved penetration of filtration materials used for aerosol research, we have developed our own filter testing system. Our filter tester (LACP, ICPF) consists of four main parts. They can be listed as follows (in the sequence as the air flows through the instrument): aerosol generator, particle size separator, filter holder and two particle detectors.

The studied filter materials were divided into four groups according to the used materials: cellulose filters, Teflon membrane filters, fiber filters (both glass and quartz fibers) and polycarbonate filters. All the tested filters are commercially available and widely used (such as Whatman, Millipore and Pall).

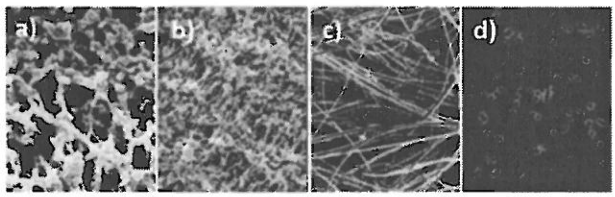

Figure 1. SEM pictures of a) mixed cellulose ester filter, b) PFTE (Teflo) filter, c) glass fiber filter, and d) polycarbonate filter.

Testing of various filter materials proved the functionality, good precision and reproducibility of a home-made filter tester. The measurements of penetration for standard commercial filter materials might be useful for many scientists and other users working with these materials. The comparison of penetrations for different types of filtration materials showed wide variety of penetration curves, MPPS and the maximum penetration. This study also confirmed our initial doubts about the standard filter efficiency testing method, regarding the used testing material, setting of MPPS and measuring only the total penetration of polydisperse aerosol. Therefore, such a study could serve also as a basis for improvements in the filter efficiency standard method, which seems to give insufficient and in some perspectives limited or even misleading information.

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Millipore, (2001). *Glass Fiber Filters*, data sheet.