Aerosol Filtration by Fibrous and Membrane Filters
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Purpose of work - Filtration is one of the most widely utilized technique in the nuclear industry for air cleaning and radioactive aerosols sampling, due to its simplicity and low cost. A wide spectrum of filters is available commercially with a wide selection of filtration, geometric and pressure drop characteristics.

In the present work, the various filters’ types are presented with reference to their advantages and limitations and to their typical industrial applications. Filtration theories of the major filters’ types are presented with the basic parameters of the filtration process including the filtration efficiency and the filter media resistance.

Methods - The aerosol filtration by fibrous and membrane filters has been a subject of numerous analytical, numerical and experimental studies during recent years. Based on these theoretical models a code has been developed in “Quattro-Pro”, which calculates the filtration efficiency of the filters as a function of the filter, aerosol and flow parameters.

Results - The important filtration mechanisms of all filters are: Brownian diffusion, interception, inertial impaction and gravitational settling. The influence of these mechanisms depends on the aerosol diameter. Fig. 1 presents the filtration efficiency of a fibrous filter by the various mechanisms. At the low diameter’s range (<0.2 µm) the Brownian diffusion is dominant whereas over 0.5 µm the interception and inertial impaction are dominant. As a consequence, there is an intermediate particle size region where none of the filtration mechanisms is dominant. In this region the particle penetration through the filter is maximal and the filtration efficiency is minimal.

Fig. 1 - Filtration efficiency by the various mechanisms, single-fiber efficiency and total efficiency of a fibrous filter as a function of the aerosol particle's diameter.
Fiber diameter - 3 µm, filter porosity - 0.9, filter width - 400 µm,
flow face velocity - 10 cm/s, aerosol density - 1 gr/cm³
Filtration process in the fibrous filter takes place through the whole filter width and therefore its efficiency increases with this thickness. In contrast, the filtration in the membrane filter takes place basically at its surface and the filter thickness has a very minor influence on its filtration efficiency, as can be seen in Fig. 2.

![Graph showing filtration efficiency vs aerosol diameter](image)

**Fig. 2** - Total filtration efficiency of a membrane filter as a function of the aerosol particle's diameter at different filter thickness values.

- Filter pore size - 4 μm, filter porosity - 0.05,
- face velocity - 10 cm/s, aerosol density - 1 gr/cm³.

**Conclusions** - Based on the parametric study it is concluded that increasing the filter diameter, decreasing the filter thickness and especially increasing the filter porosity reduce the filtration efficiency of the fibrous filter substantially. In contrast, a change in the membrane filter thickness has a minor influence on its filtration efficiency. The influence of the flow face velocity on the filtration efficiency depends on the aerosol particle diameter.