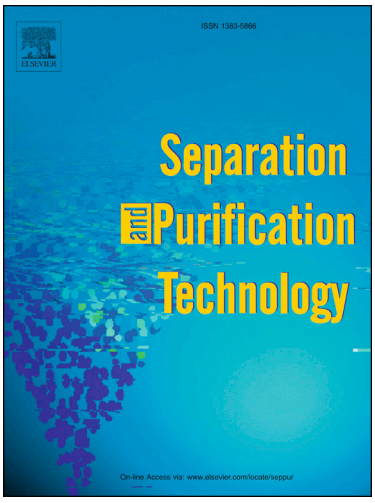

Transition from depth to surface filtration for a low-skin effect filter subject to continuous loading of nano-aerosols

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Transition from depth to surface filtration for a low-skin effect filter subject to continuous loading of nano-aerosols

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Keywords: depth-to-surface filtration transition; low-skin effect; nanofiber filter; nano-aerosols; aerosol bridging

Abstract

A thin, highly porous, nanofiber filter with low-pressure drop start out in “depth filtration” in a clean state with aerosols mostly captured by the fibers in the filter. For nanofibers with high capture efficiency, the fibers in the region upstream of the filter facing the challenging aerosol flow tends to capture more aerosols. The capture aerosols in turn can capture more incoming aerosols in this region leaving much less aerosols escaping downstream of the filter. Furthermore, these captured aerosols, forming dendritic structures, reduce the size of flowable pores in the region. This “skin region” upstream of the filter can be quite thin as compared to the entire filter thickness, yet it accounts for the large fraction of the aerosols captured in the filter as well as large fraction of the pressure drop across the filter. With more aerosols loading, the openings of the flowable pores in the skin region get blocked by aerosol dendrites that bridge across captured aerosols and fibers. These aerosol bridges subsequently build-up above the filter surface in the “surface filtration” regime. As more aerosol bridges stack-up on existing ones and interact with each other, they form ultimately a continuous cake layer on the filter surface.