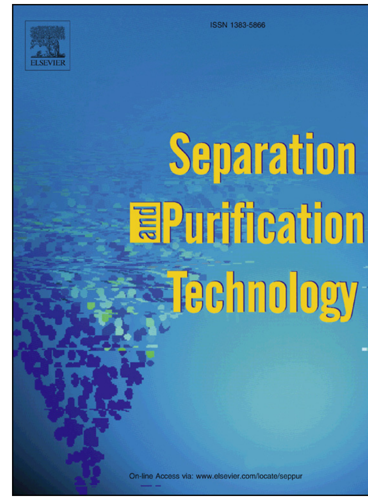

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Numerical and experimental investigations of the influence of the pleat geometry on fibrous filter performances for submicronic aerosol depth filtration

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Keywords: Air handling unit; Pleated fibrous filter; Filtration performances; CFD simulations

Abstract

The aim of this study is to combine numerical and experimental approaches to evaluate the influence of pleat geometrical parameters on the performances of pleated fibrous filters in the depth filtration stage of submicronic aerosols. For a given raw filter, three different geometrical pleat configurations (with various pleat heights and widths) are investigated at similar filtration velocities. Numerical simulations are validated based on experimental measurements in terms of pressure drop versus filtration velocity, and enable the influence of the filter geometry on the air flow pattern in its vicinity to be investigated. The influence of filter geometry on initial filtration performances is evaluated from experiments carried out in a lab-scale air handling unit with submicronic alumina particles. For this purpose, pleated filter prototypes were designed in the laboratory. The initial filtration performances in terms of fractional collection efficiency are compared regarding the numerical evolution of the velocity at the air/filter interface along the pleat.

1. Introduction

Today, people living in urban agglomerations spend about 90% of their time indoors. Currently, environmental and economic considerations are leading to the construction of low energy or positive energy buildings whose envelopes are strongly impermeable. These kinds of “confined microenvironments” need to be properly ventilated to allow air renewal and thus maintain high indoor air quality in terms of humidity, temperature, CO_2 level and exposure to air pollutants such as PM2.5 particles. For this purpose, air cleaning is necessary to remove particles, especially from the outdoor air intake in urban areas, and to treat potentially recycled indoor air, which contains mainly volatile organic compounds (VOCs) such as formaldehyde, or PM10 and PM2.5 originating from furniture, paints or people’s activities such as cooking. Thus, in-duct air cleaning devices are widely implemented in ventilation systems whose performance management is an important challenge.