Slip flow and its effect on pressure drop in fibrous nanofilters

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Abstract

The purpose of this study is the modeling and analysis of the influence of slip flow on fiber surfaces on the absorption of nanoparticles in the shallow fibrous nano-filters. The slip flow is due to nanoscale size of fibers in which the Knudsen number of the fibers is significant. In the present study, the filtration of nanoparticles suspended in air is modeled in the presence of the pressure gradient and initial inlet velocity inside the shallow fibrous filters. In the modeling and using the Euler approach, the Navier-Stokes equations are solved for a dilute mixture fluid-nanoparticle two-phase flow to analysis the flow. In the next step, suitable method is provided for the numerical solution of the governing equations of the nanoparticles motion and the simulation of the particles' deposition mechanism on the fibers with respect to the equations' type and effective forces in the nanoscale. Then, the results of the simulation are compared and validated against the experimental results. Also the presence or absence of slip condition at the boundaries on the pressure drop of filter has been compared. The results of the present study are essential for analysis of the feasibility of designing filters', which could absorb the nanoparticles using small dimensions of fibers in the diameter range of between 25 to 500 nanometer.

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