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Filtration of nanoparticles in composite filters

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ABSTRACT

Collection of nanoparticles in the particular steps of the technology of their production, and purification of the air at the workplace and atmospheric environment, requires of the efficient method of separation of particulate matter from the carrier gas. Filtration of aerosol particles using composites of nano- and microsized fibrous structures is a promising method of effective separation of nanoparticles from gases. Development in formation of specific fibrous structures promises of the construction of filters for collection of nanoparticles with high efficiency. The multiscale physical system describing the flow pattern and particles deposition in it requires other than a continuous approach for the process analysis. The lattice-Boltzmann method allows calculating the deposition efficiency of nanoparticles on both types of fibers for a very wide range of Knudsen numbers in the case of each nanofiber considering molecular, slip and continuous flow patterns. The method is also effective when boundary conditions for the solution of the Navier-Stokes equation describing the local and temporary velocity distributions change significantly due to the development of a complicated structure of deposits. The solid particles trajectories were calculated using Brownian Dynamics method. The calculations of fractional efficiency and pressure drop were compared experimental data with respect to filter structural characteristics (fiber diameter, filter depth, porosity) for the gas velocity from the range 0.02-0.35 m/s and particles diameter from the range 10-500 nm.