Deposition of Submicron Charged Spherical Particles in the Trachea of the Human Airways

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Abstract

This paper presents a numerical study of the deposition of submicron charged spherical particles caused by convection, Brownian and turbulent diffusion in a pipe with a smooth wall and with a cartilaginous ring wall structure. The model is supposed to describe deposition of charged particles in generation 0 (trachea) of the human lung. The upper airways of the human lung are characterized by a certain wall structure called cartilaginous rings (Figure 1) which are believed to increase the particle deposition when compared to an airway with a smooth wall. The problem is defined by solving the fluid flow problem with the aid of a low-Reynolds number k-epsilon model combined with a diffusion equation for the Brownian motion and Poisson's equation for the electrostatic field. The electrostatic field is generated by the space-charge density of the particles. Deposition results using COMSOL Multiphysics are compared with an analytic solution for the case of a fully-developed turbulent flow in an airway with a smooth wall.

Figures used in the abstract

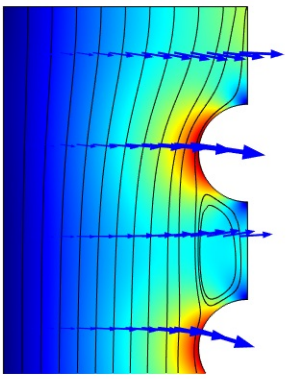

Figure 1: Fluid flow at the entrance to an airway with a cartilaginous ring structure. The arrows denote the electric field generated by the charged particles.