

432k Gas Transport in the Conducting Airways: an Axisymmetric Single-Path Model

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An axisymmetric single-path model (ASPM) for gas transport in the lower airways is developed and validated. A single airway path is represented by a series of straight tube segments interconnected by leaky transition regions that provide for flow loss at the airway bifurcations. The finite element method is used to solve the Navier-Stokes, continuity, and species convective-diffusion equations for the flow field and the species concentration distribution in the airways. The model is validated by comparing its predictions to the following experimental measurements: 1) dispersion coefficients for unsteady dispersion of an inhaled pulse of inert gas (benzene) along an airway path encompassing five generations in a scaled-up model of Weibel's symmetric airway geometry, and 2) mass transfer coefficients for steady inspiratory-directed flow of a reactive gas (formaldehyde) in both a single bifurcation and an airway path incorporating three generations of a symmetrically-branched physical model of the airways. For the latter problem, ASPM predictions are also compared with the results of three-dimensional finite element computations in the branched airway geometry. The ASPM results for the dispersion and mass transfer coefficients compare quantitatively well with both the experimental measurements and three-dimensional simulations.