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Effect of Particle Aspect Ratio and Shape Factor on Air Flow inside Pulmonary Region

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Abstract : Particles in industry, harvesting, coal mines, etc. may not necessarily be spherical in shape. In general, it is difficult to find perfectly spherical particle. The prediction of movement and deposition of non spherical particle in distinct airway generation is much more difficult as compared to spherical particles. Moreover, there is extensive inflexibility in deposition between ducts of a particular generation and inside every alveolar duct since particle concentrations can be much bigger than the mean acinar concentration. Consequently, a large number of particles fail to be exhaled during expiration. This study presents a mathematical model for the movement and deposition of those non-spherical particles by using particle aspect ratio and shape factor. We analyse the pulsatile behavior underneath sinusoidal wall oscillation due to periodic breathing condition through a non-Darcian porous medium or inside pulmonary region. Since the fluid is viscous and Newtonian, the generalized Navier-Stokes equation in two-dimensional coordinate system (r, z) is used with boundary-layer theory. Results are obtained for various values of Reynolds number, Womersley number, Forchsheimer number, particle aspect ratio and shape factor. Numerical computation is done by using finite difference scheme for very fine mesh in MATLAB. It is found that the overall air velocity is significantly increased by changes in aerodynamic diameter, aspect ratio, alveoli size, Reynolds number and the pulse rate; while velocity is decreased by increasing Forchheimer number.

Keywords : deposition, interstitial lung diseases, non-Darcian medium, numerical simulation, shape factor
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