Derivation of an anisotropic Darcy-Forchheimer equation including turbulence effects and its application to structured packings

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ABSTRACT:

We propose a methodology to derive a macroscale momentum equation that is free from the turbulence model chosen for the pore-scale simulations and that accounts for large scale anisotropy. In our method, Navier-Stokes equations are first time-averaged to form a new set of equations. Informations that describe the turbulence are embeded in a variable viscosity. This latter results from a pore-scale turbulent simulation and is considered as an input for method. The resulting continuity and momentum equations are then upscaled with regards to the volume averaging methodology to form a Darcy-Forchheimer's equation. The method also provides a closure problem that evaluates the apparent permeability tensor from a turbulent flow field computed over a periodic unit-cell. This approach is validated through 2D and 3D calculations. Finally, the method is used to evaluate the tensorial macro properties of a gas flow through structured packings.