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Numerical simulation of flow and convection diffusion in porous media by the lattice Boltzmann method at REV-scale

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A lattice Boltzmann method is applied for investigating the flow and convection diffusion processes in porous media with fractures and vugs at representative elementary volume (REV) scale. The structural parameters of porous media at pore scale are introduced into the generalized lattice Boltzmann equation (GLBE) to describe the relationship between permeability and porosity. A two-dimensional nine-speed incompressible lattice Boltzmann model, D2G9, is presented to simulate fluid flow process, while coupling with a two-dimensional five-speed D2Q5 model for convection and diffusion. Based on the different structures of porous media, the geometric variables about fractures and vugs are considered in the GLBE model to explore the influence of fractures and vugs on the flow and convection diffusion in porous media. Numerical results show that the convection diffusion coefficient in porous media formed by the accumulation of irregular particles increases with particle diameter, which is larger than that in tubular porous media because the medium resistance of the former is smaller than the latter. The fractures parallel to the flow direction intensify the convection diffusion process whereas the fractures perpendicular to the flow direction contribute little to the convection and diffusion. Besides, small vuggy porosity has nearly no effect on convection diffusion coefficient.

References

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