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Application of Lattice Boltzmann Method in Pore-scale Characterisation of Flow Dynamics in Three-Dimensional Porous Medium

Wednesday, 1 June 2022 14:50 (1h 10m)

A profound understanding of the fluid flow characteristics in porous media is essential in various industrial and engineering applications such as enhanced oil recovery, geological CO2 and H2 storage, geothermal energy storage, groundwater remediation, and pharmaceutical engineering. In this study, lattice Boltzmann method (LBM) is utilised for 3D simulation of fluid flow through two porous media, consisting of grains with the same diameter: (i) a homogeneous porous domain, in which the grains are placed with a simple cubic packing configuration, and (ii) a real randomly packed porous domain reconstructed by X-ray micro-CT images. Constant velocity and pressure boundary conditions are imposed for the inlet and outlet boundaries, respectively, and the curved solid boundaries are adequately mapped with Bouzidi boundary condition. The simulations are carried out in a wide range of Reynolds to investigate the effect of both laminar and turbulent regimes on the flow dynamics. While a Single-Relaxation-Time (SRT) LBM is applied for Reynolds lower than 1000, a Smagorinsky turbulent BGK model is adopted for higher Reynolds to ensure the stability of the simulation.

Upon convergence, the velocity magnitudes and components (along and transverse to the imposed flow direction) are extracted and analysed in order to investigate the dynamics of the flow. The analysis is conducted over a broad range of length scales, from the scale of individual pores to the scale of the entire medium, providing insights regarding the underlying pore-scale correlations in the flow. The simulation results show that even though the pore space available for the flow becomes more complex when the heterogeneity of the medium increases, its dynamics would not be completely random and could be correlated with the geometry of the medium. The fundamental insights from this study can be used to shed light on the effect of the pore geometry and grain heterogeneity on pore-scale phenomena associated with fluid flow in porous media such as solute transport and mixing, fluid-solid interaction, and sorption phenomena.

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Time Block B (14:00-17:00 CET)

Participation

Unsure

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