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Unsteady vortical structures in porous media flows[1] JUSTIN FINN, SOURABH APTE, BRIAN WOOD, Oregon State University — The pore scale character of moderate Reynolds number, inertial flow through mono-disperse packed beds of spheres is examined using numerical experiments. Direct numerical simulations are performed for flow through (i) a periodic, $3 \times 3 \times 6$ simple cubic arrangement at $Re_p = 529$, and (ii) a realistic randomly packed tube containing 326 spheres with $d_{tube}/d_{sp} = 5.96$ at $Re_p = 600$. At these Reynolds numbers, unsteady vortical regions are dominant features at the pore scale, and can have a profound effect on permeability and dispersion properties at the macro-scale. Despite similar Reynolds numbers and mean void fractions, the vortical structures observed in these two flows are remarkably different. The flow through the arranged packing is characterized by spatially and temporally periodic vortex-ring like structures, while the flow through the random packing contains many elongated helical vortices and a wider spectrum of space and time scales. The sensitive dependence of flow length and time scales and the local pore geometry is investigated using the DNS data.

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