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DNS of turbulent flow in a porous unit cell[1] SOURABH APTE, JUSTIN FINN, BRIAN WOOD, JAMES LIBURDY, Oregon State University — Turbulent flows through packed beds and porous media are encountered in a number of natural and engineered systems, however our general understanding of moderate and high Reynolds number flows is limited to mostly empirical and macroscale relationships. In this work the porescale flow physics, which are important to properties such as bulk mixing performance and permeability, are investigated using Direct Numeric Simulation of flow through a periodic face centered cubic (FCC) unit cell. This low porosity arrangement of spheres is characterized by rapid flow expansions and contractions, and thus features an early onset to turbulence [Hill & Koch, JFM 2002]. The simulations are performed using a fictitious domain approach [Apte et al, J. Comp. Physics 2009], which uses non-body conformal Cartesian grids, with resolution up to $D/\Delta = 250$ (354^3 cells total). Simulations are performed at three pore Reynolds numbers, $Re_p = 300,\ 550$ and 950, spanning a broad physical regime. The results are used to investigate the structure of turbulence in the Eulerian and Lagrangian frames, the distribution and budget of turbulent kinetic energy, and the characteristics of the energy spectrum in complex packed beds and porous media.

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