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A comparison of hydrodynamics and structure in random spherical and cylindrical packed beds

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Summary

Catalytic packed bed reactors are widely used in industrial processes. The particle packing structure in the bed introduces complex flow patterns in the system. Therefore, understanding the hydrodynamics of the fluid is key in designing these kinds of reactors since they highly affect the heat and mass distribution in the reactor. A conventional support in these reactors are cylindrical particles, as they can be prepared via extrusion. However, the orientational freedom of the cylindrical particles compared to spheres results in very different flow behavior. Therefore, this study investigates the single-phase flow behavior in packed beds of both spherical and cylindrical particles.

This study compares experimental measurements of the flow field using Magnetic Resonance Imaging (MRI) with detailed flow simulations using a ghost cell Immersed Boundary Method (IBM). To enable a quantitative comparison, the configuration of the packed beds is reconstructed from MRI for both the spherical and cylindrical packings. The flow distribution in the beds is compared at several Reynolds numbers. In addition, the range of Reynolds numbers is extended in the IBM simulations. The challenges and opportunities of both the MRI experiments and the fully resolved simulations for investigating flow in chemical reactors are discussed.

Keywords: Packed bed reactors, Direct numerical simulation, Immersed boundary method, Magnetic resonance imaging.