

Modeling the pore level fluid flow in porous media using the immersed boundary method

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Abstract This chapter demonstrates the potential of the immersed boundary method for the direct numerical simulation of the flow through porous media. A 2D compact finite differences method was employed to solve the unsteady incompressible Navier-Stokes equations with fourth-order Runge-Kutta temporal discretization and fourth-order compact schemes for spatial discretization. The solutions were obtained in a Cartesian grid, with all the associated advantages. The porous media is made of equal size square cylinders in a staggered arrangement and is bounded by solid walls. The transverse and longitudinal distances between cylinders are equal to two cylinder diameters and at the inlet a fully developed velocity profile is specified. The Reynolds number based on the cylinder diameter and maximum inlet velocity ranges from 40 to 80. The different flow regimes are identified and characterised, along with the prediction of the Reynolds number at which transition from steady to unsteady flow takes place. Additionally, the average drag and lift coefficients are presented as a function of the Reynolds number.

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