Experimental and numerical investigation of fluid flow hydrodynamics in porous media: Characterization of Darcy and non-Darcy flow regimes

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Experimental and numerical investigation of fluid flow hydrodynamics in porous media: characterization of Darcy and non-Darcy flow regimes

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Abstract

In the present study, incompressible single phase fluid percolation through different types (homogeneous and mixed isotropic) of porous media is investigated experimentally. The functional relation of pressure gradient with velocity was presented on the basis of dimensional analysis in terms of friction factor and Reynolds number based on different characteristic length (i.e. particle diameter and permeability of porous media).The experimental pressure drop data were analyzed by rigorous non-linear regression analysis. The different flow regimes exist in porous media flow were characterized and demarked according to the analysis of solid-fluid interaction, and the generation of the pressure and the viscous drags in terms of different types of Reynolds numbers $\left(\mathrm{Re}_D, \mathrm{Re}_P, \mathrm{Re}_{\sqrt{K}}\right)$. Three significant flow regimes (pre-Darcy, Darcy and non-Darcy Forchheimer flow regime) with two transition regimes (transition to Darcy and weak inertia flow regime) were observed. In addition, numerical modeling and simulations were also performed to understand the relevant micro-flow phenomena localized in the pore domain and compared the simulation results with experimental data.

Keywords: Porous media, Pore flow regimes, Non-Darcy flow, Permeability, Numerical simulation, Hydrodynamics.

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