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Non-Newtonian fluids have practical applications in very different domains. Indeed, polymer mixtures, paints, slurries, colloidal suspensions, emulsions, foams or heavy oil present complex rheologies. Among the large number of different non-Newtonian fluids an important class of behaviour is represented by the yield-stress fluids, viz. fluids that require a minimum of stress to flow. Yield stress fluids are usually modeled as a Bingham fluid or by the Herschel-Bulkley equation. Yield stress fluid displacements in porous media have been subject of particular interest due to the yield-stress behaviour of heavy-oil [1] or foam [2].

Recently, it had been shown numerically [3], that in two-dimensional heterogeneous porous media the pressure-flow relation for Bingham fluids shows three different scaling regimes.

Different pressure drops ΔP were applied in order to drive the fluid. The authors determined then a generalized Darcy equation by evaluating the flow in the porous structure. Three different scaling regimes were observed. For low and high pressure drops linear scaling was observed, whereas in the intermediate regime, flow rate is a quadratic function of the pressure drop. Regime I corresponds to the situation where fluid is flowing in only one channel. Here, the relation between flow rate and pressure drop is given by the non-Newtonian Poiseuille law which is linear in velocity in the case of Bingham fluids. During Regime II an increase in pressure triggers the opening of new paths and the relation between flow rate and the difference in pressure to the critical yield pressure becomes quadratic. Finally, Regime III corresponds to the situation where all the fluid has been sheared.

However, this behaviour has not been observed experimentally for a bead pack [4].

The aim of the present work is to investigate experimentally the nonlinear generalized Darcy equation for yield stress fluids when flowing in a heterogeneous porous medium. To this goal, Carbopol, a yield stress fluid, is injected into porous media for different flow rates and the pressure drop is measured. Porous media of different microstructures will be used in order to show the dependence of this generalized Darcy equation on the heterogeneity of the geometry.

References

[1] G. Barenblatt, V. Entov, V. Ryzhik, Theory of fluid flows through natural rocks (Norwell, MA (USA); Kluwer Academic Publishers, 1989)
[2] W.R. Rossen, Theory of mobilization pressure gradient of flowing foams in porous media: I. Incompressible foam, J. Colloid Interface Sci. 136(1), 1 (1990), ISSN 0021-9797
[3] L. Talon, D. Bauer On the determination of a generalized Darcy equation for yield-stress fluid in porous media using a Lattice-Boltzmann TRT scheme, EPJ 2013
[4] T. Chevalier, C. Chevalier, X. Clain, J.C. Dupla, J. Canou, S. Rodts, P. Coussot, Darcy's law for yield stress fluid flowing through a porous medium, J. of Non-Newtonian Fluid Mech. 195 (2013) 57–66