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Contribution ID: **19**

Type: **Poster (+) Presentation**

How does the power law dependency of flow rate on pressure gradient when viscous and capillary forces compete, scale with system size?

Tuesday, 1 June 2021 20:00 (1 hour)

When two immiscible fluids flow in a porous media at rates where the capillary and viscous forces compete, there is growing experimental,
numerical and theoretical evidence that the flow rate depends on the pressure gradient minus a threshold pressure to a power between 1.5 to 2
[1]. At higher flow rates, where viscous forces dominate, the flow rate becomes proportional to the pressure gradient.

Imagine a porous medium of linear size L. There is a pressure difference ΔP between inlet and outlet, resulting in a flow rate
Q across it. When the viscous and capillary forces compete, we have $Q \sim (\Delta P - P_t)^\beta$ where P_t is the threshold pressure. When the viscous forces dominate, we have $Q \sim \Delta P$. We pose here two
questions: (1) what happens to the threshold pressure P_t as $L \to \infty$ and (2) what happens to the pressure difference
ΔP_c at which Q goes from non-linear to linear dependence on ΔP?

Based on analytical result from the capillary fiber bundle model and numerical evidence from a dynamic network simulator [2], we demonstrate that $P_t \to 0$ and $\Delta P_c \to 0$ in this limit, $L \to \infty$.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

[1] Tallakstad, K. T., Knudsen, H. A., Ramstad, T., Løvoll, G., Måløy, K. J., Toussaint, R., and Flekkøy, E. G., Phys. Rev. Lett., 102, 074502 (2009); Tallakstad, K. T., Løvoll, G., Knudsen, H. A., Ramstad, T., Flekkøy, E. G., and Måløy, K. J., Phys. Rev. E, 80, 036308 (2009); Sinha, S. and Hansen, A., EPL, 99, 44004 (2012); Roy, S., Hansen, A. and Sinha, S., Front. Phys. 7, 92 (2020).Aursjø, O., Erpelding, M., Tallakstad, K. T., Flekkøy, E. G., Hansen, A., and Måløy, K. J., Front. Phys. 2, 63 (2014); Sinha, S., Bender, A.T., Danczyk, M., Keepseagle, K., Prather, C.A., Bray, J.M., Thrane, L.W., Seymour, J.D., Codd, S.L. and Hansen, A., Transport Por. Media, 119, 77 (2017); Gao, Y., Lin, Q., Bijeljic, B. and Blunt, M. J., Water Resources Research, 53, 10274 (2017); Gao, Y., Lin, Q., Bijeljic, B. and Blunt, M. J., Phys. Rev. Fluids, 5, 013801 (2020); Zhang, Y., Bijeljic, B., Gao, Y., Lin, Q. and Blunt, M. J., eartharXiv, https://doi.org/10.31223/osf.io/2rxbn (2020).
[2] Roy, S., Sinha, S. and Hansen, A., arXiv:1912.05248.

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