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A quantitative study of transition states between single-phase steady flows in a microfluidic device

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Velocity fields in flow in permeable media are of great importance to many subsurface processes such as geologic storage of CO2, oil and gas extraction, and geothermal systems. Steady-state flow is characterized by velocity fields that do not change significantly over time. The flow field transitions to a new steady state once it experiences a disturbance such as a change in flow rate or in pressure gradient. This transition is often assumed to be instantaneous, which justifies expressing constitutive relations as functions of instantaneous phase saturations. In this work, we examine the evolution of velocity fields in a surrogate quasi-2D permeable medium using a microfluidic device and a high-speed camera. Tracer particles, i.e., microspheres with a diameter of one micrometer, are injected in to the medium along with DI water. The evolution of the velocity field is examined by tracing these particles in the captured images using a multi-pass particle image velocimetry algorithm. The results suggest that transition period between steady-states for an incompressible fluid takes a finite and non-negligible amount of time. Finally, we examine the impact of the magnitude of the change in the pressure gradient on this transition period.

Time Block Preference

Time Block C (18:00-21:00 CET)

References

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Primary authors: SUN, Jindi; Mr LI, Ziqiang (University of Wyoming); ARYANA, Saman (University of Wyoming)

Presenter: SUN, Jindi

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