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Discontinuous Phase Flow in Porous Media: A Pore-scale Approach

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Discontinuous phase flow behavior is different from that of the continuous phase flow. In addition to that, depending on factors such as the pore structure, the wettability, the discontinuous phase can exist in many forms. Each form may exhibit a specific flow behavior. Numerous studies have been performed on the mobilization of discontinuous phases. However, many works have been performed on two-dimensional models, only few works considered in three-dimensional models. Different geometries have been also studied in literature. A complete understanding of the discontinuous phase flow requires to study a large range of parameters that affect the flow including drawing clear differences between the 2-D and 3-D approaches, the geometries, and different forms of discontinuous phases. This requires a pore-scale perspective where fluid interfaces are taken into account.

To study the discontinuous phase flow, we have performed pore-scale simulations. The phase morphology and mobilization pressure have been investigated. Research have shown that isolated droplets are one of the most difficult trapped discontinuous phase to displace. In unconstructed channels, the discontinuous phase is mainly trapped due to the surface wettability contrast. In constricted channels, the comparison of 2-D and 3-D models have shown that 3-D models capture the morphological shapes that cannot be captured in 2-D models, such as the saddle-shape in fractional-wet porous media. Furthermore, droplet dynamics in a fractionally-wet channel do not necessarily follow the same behavior as in a uniform capillary channel and cannot be predicted using uniform wettability surfaces depicted by an average contact angle. In particular, the pressure difference needed to push the droplet through the restriction with fractional wettability is lower than that for a uniform channel with a constant contact angle representing the less favorable wettability state. Due to the geometry, isolated droplets can be categorized as long droplets and finite droplets. The discrepancy in their mobilization have been studied. We have also considered a discontinuous phase spanning multiple pores. The results have shown that the existing models can not accurately capture topological changes of a ganglion.

Participation

In-Person

References

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