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Transport of Contaminant Slices under Unfavorable Viscosity Ratio in Porous Media with Dead-End Pores

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Less cleanup efficiency or sweep efficiency is a significant challenge in a variety of applications such as groundwater remediation, CO2 sequestration, hydrogen geological storage, and enhanced oil recovery. Two key factors in the miscible displacements are the viscous fingering (VF) and fluid retention. The VF happens when a less-viscous fluid displaces a more-viscous one. While leading to large unswept areas by miscible VF, it is widely believed in swept areas the contaminant can be 100% cleaned up. This is however not true, especially considering the fluid retention, which however cannot be captured by previous studies in the VF research community. Here, we employ a fundamentally different model to investigate the transport and retention of contaminant slices in porous media with non-negligible dead-end pores. We show by highly accurate numerical simulation the impact of dead-end pores on VF dynamics and temporal and spatial distribution of contaminant slices. Our research shows that porous medium not only acts as a medium for fluids to transport but also first acts as a sink and then a source of contaminant in newly swept areas. Furthermore, the local mass transfer between well-connected and dead-end pores substantially modifies VF dynamics and distribution of contaminant slices. We also find the maximum uncleaned contaminant in swept areas is 9-15 times higher than the classical models, when 40% dead-end pore volume is considered in porous media. Our research challenges the traditional viewpoint that miscible displacements can 100% clean up contaminant. It provides new insights into the roles of porous media and allows better characterization of contaminant transport, retention, and cleanup in aquifer system.

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References

Time Block Preference

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Participation

Online

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